JANUARY 11, 2023

CITY OF GREENVILLE

PROJECT #GREN2202-0200
DOWNTOWN GREENVILLE TECHNOLOGY UPGRADES
PROJECT SPECIFICATION MANUAL

251 N. ROSE ST, STE 200, KALAMAZOO, MI 49007 WWW.AETECH.DESIGN

SECTION 000110 - TABLE OF CONTENTS

SECTION 000111 – PROJECT INFORMATION

PART 1 - GENERAL

1.1 GENERAL INFORMATION

A. Project Name: Downtown Greenville Technology Upgrades

B. Owner: City of Greenville

C. Owner's Address: 411 S. Lafayette St, Greenville, MI 48838

D. Designer's Project No.: GREN2202-0200

E. Designer: AE Tech Design
251 N. Rose St, Suite 200
Kalamazoo, MI 49007
Phone: 269.203.2444
Website: https://aetech.design

F. Project Issued: 1/11/2023

1.2 SUMMARY

A. Section includes:
1. Scope
2. Responsibility
3. Documents
4. Schedule

1.3 SCOPE

A. The scope of this bid package:
1. Upgrades to the City's downtown district, including but not limited to installing and terminating fiber optic cabling to light poles, installing device enclosures, distributed audio systems, video surveillance systems, and wired and wireless networking devices.

B. The work may be awarded to a single prime contractor. This contractor may use subcontractors to provide a complete solution. The work may also be awarded to multiple contractors. All approaches will be considered by the owner, based on the owners' best interests.

C. Please see the 'Work Scope Legend' on drawing page TG02 for a detailed list of scope by bid category.

1.4 RESPONSIBILITY

A. AE Tech Design is administering the bid process along with the City of Greenville and will manage the awarded contractor(s).

B. AE Tech Design is managing the construction by awarded contractor(s).

C. Awarded contractor(s) shall coordinate all construction activities with AE Tech Design and the City of Greenville, making sure to co-operate with all trade contractors when necessary.

1.5 DOCUMENTS

A. The drawings within this bid document set reflect technology upgrades and modifications to the City's downtown district and City Hall building.

1.6 SCHEDULE

A. The work will start at a date coordinated between AE Tech Design, the City of Greenville, and the awarded contractor(s).

B. The Owner desires substantial completion before 12/29/2023

C. Timelines above are subject to expansion only due to product availability. The ability to adjust and be flexible under the current supply-chain circumstances will be required by the awarded contractor(s).

END OF SECTION 000100

DOCUMENT 000115 - LIST OF DRAWING SHEETS

1.1 LIST OF DRAWINGS.

A. Drawings: Drawings consist of the Contract Drawings and other drawings listed on the Table of Contents page of the separately bound drawing set titled “Downtown Technology Upgrades”, dated “1/11/2023”, as modified by subsequent Addenda and Contract modifications.

B. List of Drawings: Drawings consist of the following Contract Drawings and other drawings of type indicated:

1. Downtown Technology Upgrades
    a. TG001 Titlesheet
    b. TG002 Technology General Information
    c. TS01 Technology Site Plan – Composite
    d. TS02 Technology Site Plan – Surveillance
    e. TS03 Technology Site Plan – Paging
    f. TS04 Technology Site Plan – Network
    g. TS05 Technology Site Plan – Details
    h. T301 Structured Cabling General Information
    i. T302 Structured Cabling Enlarged Tech Closet Plan
    j. T303 Structured Cabling Light Pole Details
    k. T304 Structured Cabling Support Information
    l. T401 Security Systems General Information
    m. T501 Distributed Systems General Information

END OF DOCUMENT 000115

DOCUMENT 002113 - INSTRUCTIONS TO BIDDERS

1.1 INSTRUCTIONS TO BIDDERS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. Bidder's Representations
   2. Bidding Documents including addenda and substitution procedures
   3. Bidding Procedures including preparation of bids, bid security, submission of bids, modification, or withdrawal of bids
   4. Consideration of Bids including bid opening, rejection of bids, and Acceptance (Award) of Bid
   5. Post-Bid Information including Contractor's Qualification Statement, Owner's Financial Capability, and Submittals
   6. Performance Bond and Payment Bond requirements
   7. Enumeration of the Proposed Contract Documents
   8. Bidder's Intent to Bid

1.3 DEFINITIONS

A. Bidding Documents include the Bidding Requirements and the Proposed Contract Documents. The Bidding Requirements consist of the advertisement or invitation to bid, Instructions to Bidders, supplementary instructions to bidders, the bid form, and any other bidding forms. The Proposed Contract Documents consist of the unexecuted form of Agreement between the Owner and Contractor and that Agreement's Exhibits, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, all Addenda, and all other documents enumerated in Article 8 of these Instructions.

B. Definitions set forth in the General Conditions of the Contract for Construction, or in other Proposed Contract Documents apply to the Bidding Documents.

C. Addenda are written or graphic instruments issued by the Designer, which, by additions, deletions, clarifications, or corrections, modify or interpret the Bidding Documents.

D. A Bid is a complete and properly executed proposal to do the Work for the sums stipulated therein, submitted in accordance with the Bidding Documents.

E. The Base Bid is the sum stated in the Bid for which the Bidder offers to perform the Work described in the Bidding Documents, to which Work may be added or deleted by sums stated in Alternate Bids.

F. An Alternate Bid (or Alternate) is an amount stated in the Bid to be added to or deducted from, or that does not change, the Base Bid if the corresponding change in the Work, as described in the Bidding Documents, is accepted.

G. A Unit Price is an amount stated in the Bid as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, as described in the Bidding Documents.

H. A Bidder is a person or entity who submits a Bid and who meets the requirements set forth in the Bidding Documents.

I. A Sub-bidder is a person or entity who submits a bid to a Bidder for materials, equipment, or labor for a portion of the Work.

1.4 BIDDER'S REPRESENTATIONS

A. By submitting a Bid, the Bidder represents:
1. The Bidder has read and understands the Bidding Documents.
2. The Bidder understands how the Bidding Documents relate to other portions of the Project, if any, being bid concurrently or presently under construction.
3. The Bid complies with the Bidding Documents.
4. The Bidder has visited the site, become familiar with local conditions under which the Work is to be performed, and has correlated the Bidder's observations with the requirements of the Proposed Contract Documents.
5. The Bid is based upon the materials, equipment, and systems required by the Bidding Documents without exception.
6. The Bidder has investigated all required fees, permits, and regulatory requirements of authorities having jurisdiction and has properly included in the submitted Bid the cost of such fees, permits, and requirements not otherwise indicated as provided by Owner.
7. The Bidder is a properly licensed Contractor according to the laws and regulations of the State of Michigan and meets qualifications indicated in the Procurement and Contracting Documents.
8. The Bidder has incorporated into the Bid adequate sums for work performed by installers whose qualifications meet those indicated in the Procurement and Contracting Documents.

1.5 BIDDING DOCUMENTS

A. Distribution
1. Bidders shall obtain complete Bidding Documents, as indicated below:
a. https://aetech.design/bid-opportunities
b. https://greenvillemi.org/business/bids___rfp_s/index.php
2. Bidders shall use complete Bidding Documents in preparing Bids. Neither the Owner nor Designer assumes responsibility for errors or misinterpretations resulting from the use of incomplete Bidding Documents.
3. The Bidding Documents will be available for the sole purpose of obtaining Bids on the Work. No license or grant of use is conferred by distribution of the Bidding Documents.

B. Modification or Interpretation of Bidding Documents
1. The Bidder shall carefully study the Bidding Documents, shall examine the site and local conditions, and shall notify the Designer of errors, inconsistencies, or ambiguities discovered and request clarification or interpretation pursuant to Section 1.5 B 2.
2. Requests for clarification or interpretation of the Bidding Documents shall be submitted by the Bidder in writing and shall be received by the Designer no later January 30th, 2023, 5:00 p.m., addressed to ecain@aetech.design.

3. Modifications and interpretations of the Bidding Documents shall be made by Addendum. Modifications and interpretations of the Bidding Documents made in any other manner shall not be binding, and Bidders shall not rely upon them.

C. Substitutions
1. The materials, products, and equipment described in the Bidding Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution.

D. Substitution Process
1. Written requests for substitutions shall be received by the Designer at least five (5) business days prior to the date for receipt of Bids. Requests shall be submitted in the same manner as that established for submitting clarifications and interpretations in Section 1.5 B 2.
2. Requests shall include (1) the name of the material or equipment specified in the Bidding Documents; (2) the reason for the requested substitution; (3) a complete description of the proposed substitution including the name of the material or equipment proposed as the substitute, performance and test data, and relevant drawings; and (4) any other information necessary for an evaluation. The request shall include a statement setting forth changes in other materials, equipment, or other portions of the Work, including changes in the work of other contracts or the impact on any Project Certifications that will result from incorporation of the proposed substitution.
3. The burden of proof of the merit of the proposed substitution is upon the proposer. The Designer's decision of approval or disapproval of a proposed substitution shall be final.
4. If the Designer approves a proposed substitution prior to receipt of Bids, such approval shall be set forth in an Addendum. Approvals made in any other manner shall not be binding, and Bidders shall not rely upon them.

E. Addenda
1. Addenda will be transmitted to Bidders known by the issuing office to have received complete Bidding Documents as well as posted to previously linked website. It is the contractor's responsibility to make sure they have received all addenda and acknowledge such on the bid form.
2. Addenda will be issued no later than January 31st, 2023, except an Addendum withdrawing the request for Bids or one which includes postponement of the date for receipt of Bids.
3. Prior to submitting a Bid, each Bidder shall ascertain that the Bidder has received all Addenda issued, and the Bidder shall acknowledge their receipt in the Bid.

2.1 BIDDING PROCEDURES

A. Intent to Bid

1. Although not required, prospective Bidders are encouraged to submit an Intent to Bid Form that may be found in the Section 004123 "Bid Forms" to Evan Cain ecain@aetech.design.

B. Preparation of Bids

1. The Owner will receive bids physically at the following address:
    1) Greenville City Hall
    411 S. Lafayette St.
    Greenville, MI 48838
2. Bids shall include the forms included with or identified in the Bidding Documents.
3. All blanks on the bid form shall be legibly executed.
4. Sums shall be expressed in both words and numbers, unless noted otherwise on the bid form. In case of discrepancy, the amount entered in words shall govern.
5. All requested Alternates shall be bid. If no change in the Base Bid is required, enter "No Change" or as required by the bid form.
6. Where two or more Bids for designated portions of the Work have been requested, the Bidder may, without forfeiture of the bid security, state the Bidder's refusal to accept award of less than the combination of Bids stipulated by the Bidder. The Bidder shall neither make additional stipulations on the bid form nor qualify the Bid in any other manner.
7. The Digital copy of the Bid shall state the legal name and legal status of the Bidder. As part of the documentation submitted with the Bid, the Bidder shall provide evidence of its legal authority to perform the Work in the jurisdiction where the Project is located. The digital copy of the Bid shall be signed by the person or persons legally authorized to bind the Bidder to a contract. A Bid by a corporation shall further name the state of incorporation and have the corporate seal affixed. A Bid submitted by an agent shall have a current power of attorney attached, certifying the agent's authority to bind the Bidder.
8. The Bid shall include unit prices when called for by the Procurement and Contracting Documents. Owner may elect to consider unit prices in the determination of award. Unit prices will be incorporated into the Contract.
9. Bid **must** include a detailed Materials List for each section of your response. It is important that all items are listed. It will not be assumed that items are included unless they are specifically listed. Material Lists shall include line-item pricing, manufacturer and model number for all major components, cables, and labor.
10. Owner may elect to disqualify a bid due to failure to submit a bid in the form requested, failure to bid requested alternates or unit prices, failure to complete entries in all blanks in the Bid Form, or inclusion by the Bidder of any alternates, condition, limitations, or provisions not called for.
11. Bidders are responsible for all sales and use tax.
12. A Bidder shall incur all costs associated with the preparation of its Bid.

2.2 Bid Security

A. Each Bid shall be accompanied by a bid security in the amount of **five percent (5%)** of the Base Bid. Bid security may be in the form of a Bid Bond, Certified Check, or Cashier's Check. A bona fide digital copy of the bid security must be included with the bid response. The official check or bid bond will be requested should the bid security be called in. When submitting a Certified Check or Cashier's Check for multiple Bids, a separate check or money order is recommended to accompany each bid. An uncertified personal or company check does not constitute a Bid Security.

B. The Bidder pledges to enter into a Contract with the Owner on the terms stated in the Bid and shall, furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder. Should the Bidder refuse to enter into such Contract or fail to furnish such bonds, the amount of the bid security may at the Owner's determination, be forfeited to the Owner as liquidated damages, not as a penalty. In the event the Owner fails to comply with Section 1.8 B, the amount of the bid security shall not be forfeited to the Owner.

1. The attorney who executes the bond on behalf of the surety shall affix to the bond a certified and current copy of an acceptable power of attorney. The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.
2. The Owner will have the right to retain the bid security of Bidders to whom an award is being considered until (a) the Contract has been executed and bonds, if required, have been furnished; (b) the specified time has elapsed so that Bids may be withdrawn; or (c) all Bids have been rejected. However, if no Contract has been awarded or a Bidder has not been notified of the acceptance of its Bid, a Bidder may, beginning 120 days after the opening of Bids, withdraw its Bid and request the return of its bid security.

C. Submission of Bids

1. A Bidder shall submit its Bid as indicated.
2. Deliver bids physically or mail bids to:
    1) Greenville City Hall
    411 S. Lafayette St.
    Greenville, MI 48838
    2) Paper copies of the Bid, the bid security, and any other documents required to be submitted with the Bid shall be enclosed in a sealed opaque envelope. The envelope shall be addressed to the party receiving the Bids and shall be identified with the Project name, the Bidder's name, and address. If the Bid is sent by mail, the sealed envelope shall be enclosed in a separate mailing envelope with the notation "SEALED BID ENCLOSED" on the face thereof.
3. Provide **one (1) original** and **one (1) copy** of your response, and **one (1) digital copy via USB** storage in a sealed envelope clearly marked:
    ATTN: HEATHER FEAZEL
    CITY OF GREENVILLE – TECHNOLOGY BID RESPONSE - DO NOT OPEN
4. Bids shall be submitted by **February 7th, 2023 by 2:00pm**. Bids submitted after the date and time for receipt of Bids, or at an incorrect place, will not be accepted.
5. The Bidder shall assume full responsibility for timely delivery to the email address designated for receipt of Bids.
6. A Bid submitted by any method other than as provided in this Section will not be accepted.

D. Modification or Withdrawal of Bid

1. Prior to the date and time designated for receipt of Bids, a Bidder may submit a new Bid to replace a Bid previously submitted, or withdraw its Bid entirely, by notice to the party designated to receive the Bids. Such notice shall be received and duly recorded by the receiving party on or before the date and time set for receipt of Bids. The receiving party shall verify that replaced or withdrawn Bids are removed from the other submitted Bids and not considered. Notice of submission of a replacement Bid or withdrawal of a Bid shall be worded so as not to reveal the amount of the original Bid.
2. Withdrawn Bids may be resubmitted up to the date and time designated for the receipt of Bids in the same format as the original bid, provided they fully conform with these Instructions to Bidders. Bid security shall be in an amount sufficient for the Bid as resubmitted.

a. Such modifications to or withdrawal of a bid may only be made by persons authorized to act on behalf of the Bidder. Authorized persons are those so identified in the Bidder's corporate bylaws, specifically empowered by the Bidder's charter or similar legally binding document acceptable to Owner, or by power of attorney. Make such documentation available to the Owner at the time of seeking modifications or withdrawal of the Bid.

3. After the date and time designated for receipt of Bids, a Bidder who discovers that it made a clerical error in its Bid shall notify the Designer of such error within two days, or pursuant to a timeframe specified by the law of the jurisdiction where the Project is located, requesting withdrawal of its Bid. Upon providing evidence of such error to the reasonable satisfaction of the Designer, the Bid shall be withdrawn and not resubmitted. If a Bid is withdrawn, the Owner has the right to determine whether to retain the bid security or return the bid security in part or whole.

2.3 CONSIDERATION OF BIDS

A. Opening of Bids

B. If stipulated in an advertisement or invitation to bid, or when otherwise required by law, Bids properly identified and received within the specified time limits will be publicly opened and read aloud. A summary of the Bids may be made available to Bidders.

C. The Bids will be read aloud at 2:00pm on February 7th, 2023, at the Greenville City Hall.

D. Rejection of Bids

1. Unless otherwise prohibited by law, the Owner shall have the right to reject any or all Bids.
   a. Owner reserves the right to reject a bid based on Owner's and Designer's evaluation of qualification information submitted following opening of bids. Owner's evaluation of the Bidder's qualifications will include: record of quality of completed work, record of Project completion and ability to complete, record of financial management including financial resources available to complete Project and record of timely payment of obligations, record of Project site management including compliance with requirements of authorities having jurisdiction, record and number of current claims and disputes and the status of their resolution, and qualifications of the Bidder's proposed Project staff and proposed subcontractors.

E. Acceptance of Bid (Award)

1. It is the intent of the Owner to award a Contract to the lowest responsive and responsible Bidder, provided the Bid has been submitted in accordance with the requirements of the Bidding Documents. Unless otherwise prohibited by law, the Owner shall have the right to waive informalities and irregularities in a Bid received and to accept the Bid which, in the Owner's judgment, is in the Owner's best interests.
2. Unless otherwise prohibited by law, the Owner shall have the right to accept Alternates in any order or combination, unless otherwise specifically provided in the Bidding Documents, and to determine the lowest responsive and responsible Bidder on the basis of the sum of the Base Bid and Alternates accepted.

F. Contract

1. A purchase order will be issued to the awarded contractor(s) if required by the owner.
2. An AIA Document A132-2019 Standard Form of Agreement between Owner and Contractor, will be issued between the owner and contractor.

2.4 POST-BID INFORMATION

A. Submittals
1. After notification of selection for the award of the Contract, the Bidder shall, as soon as practicable or as stipulated in the Bidding Documents, submit in writing to the Owner through the Designer:
   a. A designation of the Work to be performed with the Bidder's own forces.
   b. Names of the principal products and systems proposed for the Work and the manufacturers and suppliers of each, if not included in the bid; and
   c. Names of persons or entities (including those who are to furnish materials or equipment fabricated to a special design) proposed for the principal portions of the Work, if not included in the bid.
3. The Bidder will be required to establish to the satisfaction of the Designer and Owner the reliability and responsibility of the persons or entities proposed to furnish and perform the Work described in the Bidding Documents.
4. Prime contractors must adhere to owner guidelines for working on city property. Contractor shall not assign any of its employees, agents, or other individuals to perform any services in the District's facilities or programs sites if that individual:
   1) Is listed on the Michigan Sex Offender Registry, www.mipsor.state.mi.us .
   2) Is listed on the Federal Sex Offender Registry, www.nsopw.gov .
   3) Has felony convictions within the most recent (7) seven years.
   4) Has not passed a 5-50 drug screen, testing negative for the following drugs:
      a) Amphetamines
      b) Methamphetamines
      c) Cocaine
      d) Codeine
      e) Methadone
      f) Morphine
      g) Phencyclidine (PCP)
      h) Marijuana
5. Prior to the execution of the Contract, the Designer will notify the Bidder if either the Owner or Designer, after due investigation, has reasonable objection to a person or entity proposed by the Bidder. If the Owner or Designer has reasonable objection to a proposed person or entity, the Bidder may, at the Bidder's option, withdraw the Bid or submit an acceptable substitute person or entity. The Bidder may also submit any required adjustment in the Base Bid or Alternate Bid to account for the difference in cost occasioned by such substitution. The Owner may accept the adjusted bid price or disqualify the Bidder. In the event of either withdrawal or disqualification, bid security will not be forfeited.
6. Persons and entities proposed by the Bidder and to whom the Owner and Designer have made no reasonable objection must be used on the Work for which they were proposed and shall not be changed except with the written consent of the Owner and Designer.

2.5 PERFORMANCE BOND AND PAYMENT BOND

A. Bond Requirements
1. The successful Bidder shall furnish bonds covering the faithful performance of the Contract and payment of all obligations arising thereunder.
   a. Both a Performance and a Payment Bond will be required, each in an amount equal to 100 percent of the Contract Sum.

2. The cost shall be included in the Bid.
3. The Bidder shall provide surety bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.
4. The Penal Sum of the Payment and Performance Bonds shall be the amount of the Contract Sum.

B. Time of Delivery and Form of Bonds
1. The Bidder shall deliver the required bonds to the Owner no later than the date of Execution of the Contract. If the Work is to commence sooner than the executed contract, the Bidder shall, prior to commencement of the Work, submit evidence satisfactory to the Owner that such bonds will be furnished and delivered. Owner may deem the failure of the Bidder to deliver required bonds within the period of time allowed a default.
2. Unless otherwise provided, the bonds shall be written on AIA Document A312, Performance Bond and Payment Bond.
3. Bonds shall be executed and be in force on the date of the execution of the Contract.
4. Bonds shall be secured from surety bond companies licensed to underwrite within the State of Michigan, shall be included on the United States Department of Treasury's most recent Listing of Certified Surety Companies (Circular 570), and shall currently hold a rating of A- or better from the A.M. Best Company. Both form and substance shall be subject to the review and approval of the Owner and Construction Manager. When requested, Bidders shall indicate the name and address of their bonding company and agent.

2.6 CONTRACTOR'S AND SUBCONTRACTOR'S LIABILITY INSURANCE

A. The Contractor shall not commence work until he has obtained such insurance as is required by the Contract Documents,

B. The Insurance required shall be:
1. Worker's Compensation policy including Employer's Liability.
2. Comprehensive General Liability policy including coverage of liability for:
   a. Premises and Operations;
   b. Elevators;
   c. Independent Contractors;
   d. Products;
   e. Completed Operations for one year after substantial completion;
   f. Broad Form Property Damage coverage on an occurrence basis, including explosion, collapse and underground hazards;
   g. Contractual, as applicable to the Contractor's obligations under the Indemnification Agreement contained in the Contract; and
   h. Personal Injury.
3. Comprehensive Automobile Liability policy including coverage for owned, non-owned, leased and hired automobiles, and property damage on an occurrence basis.
4. "The insurance shall be carried with companies authorized to do business in Michigan and acceptable to the Construction Manager and Owner. It shall remain in force for the duration of the contract and shall provide coverage as follows:
   a. Commercial general Liability

1. Bodily Injury+ Property damage	$1,000,000	Each Occurrence (Incl. Completed Operations – 3 years from final completion.

2. Aggregate	$2,000,000	Gen. Agg. (must apply separately to each project)
	$2,000,000	Products & Completed Operations Aggregate (Combined Single Limits)
	$1,000,000	Personal/Advertising Injury
3. Pollution Legal Liability	$2,000,000	Per occurrence, if claims made, for 2 Years following final acceptance by Owner, or through warranty period, whichever is longer

b.	Comprehensive automobile Liability Bodily Injury & Property Damage	$1,000,00	Each Occurrence (Combined Single Limits)
c.	Workers Compensation	$500,000 $500,000 $500,000	Employer's Liability (Each Accident) Disease-Policy Limit Disease-Each Employee
d.	Umbrella Coverage	$200,000,000	Per Occurrence & Aggregate
e.	Professional Liability for design	$200,000,000	Per Occurrence & Aggregate

f. The City of Greenville and AE Tech Design must be named as additional insureds.

2.7 ENUMERATION OF THE PROPOSED CONTRACT DOCUMENTS

A. The proposed Contract Documents consist of the following documents:
   1. Certificate of Liability Insurance
   2. Specification sections and drawings issued for bid dated January 11th, 2023 and any subsequent addenda associated with the bidding process
   3. Contractor's bid
   4. Post-bid interview meeting minutes
   5. Performance and Payment Bonds

2.8 END OF DOCUMENT 002113

DOCUMENT 004123 – BID FORM

1.1 SUMMARY

A. This section includes the forms to be used by bidders for the purposes of bidding the project

B. Intent to Bid

C. Bid Including:
1. Vendor Profile
2. Iran Sanctions Act Affidavit of Compliance
3. Technology References
4. Bid Bond Form (AIA Document A310) or bid security

1.2 INTENT TO BID

A. Submit form to Evan Cain, AE Tech Design, ecain@aetech.design

B. Project Name: Downtown Technology Upgrades

C. Company Name: _____

D. Company Street Address:_____

E. Company City, State and zip code:_____

F. Contact Name:_____

G. Email Address:_____

H. Phone:_____

1.3 VENDOR PROFILE

A. Company Name: _____

B. Company Street Address:_____

C. Company City, State and zip code:_____

D. Contact Name:_____

E. Email Address:_____

F. Phone:_____

G. Fax:_____

H. Date Founded: _____ Number of employees: _____

I. Total revenue last fiscal year: _____

J. Type of Organization (Corporation, Partnership, LLC, etc.): _____

K. Has organization ever had a contract terminated prior to completion: _____

L. Has organization ever failed to complete a project: _____

M. Has organization ever filed for bankruptcy, reorganization, or receivership: _____

N. Number of full-time technicians qualified to perform work on this project: _____

O. Has organization ever been involved in a lawsuit with Owners, Architechts/Engineers or other contractors within the last five years: _____

1.4 IRAN ECONOMIC SANCTIONS ACT AFFIDAVIT OF COMPLIANCE - MICHIGAN PUBLIC ACT NO. 517 OF 2012

A. The undersigned, the owner or authorized officer of the below-named contractor (the "Contractor"), pursuant to the compliance certification requirement provided in the City of Greenville (the "Owner") RFP for Downtown Greenville Technology Improvements (the "RFP"), hereby certifies, represents and warrants that the Contractor (including its officers, directors and employees) is not an "Iran linked business" within the meaning of the Iran Economic Sanctions Act, Michigan Public Act No. 517 of 2012 (the "Act"), and that in the event Contractor is awarded a contract as a result of the aforementioned RFP, the Contractor will not become an "Iran linked business" at any time during the course of performing any services under the contract.

B. The Act defines an Iran Linked Business as an individual or any entity, including all successors, parent companies, subsidiaries and companies under common control, engaged in investment activities of $20,000,000.00 or more with the energy sector of Iran, including providing products used to construct or maintain oil or liquefied natural gas pipelines.

C. The Contractor further acknowledges that any person who is found to have submitted a false certification is responsible for a civil penalty of not more than $250,000.00 (or 2 times the amount of the contract, or proposed contract, for which the false certification was made), whichever is greater. Additionally, the cost of the City's investigation, and reasonable attorney fees, will be added to the fine. Moreover, any person who submitted a false certification shall be ineligible to bid on a Request for Proposal for three (3) years from the date it is determined that the person has submitted the false certification.

D. The City shall not accept a bid that does not include a sworn and notarized Affidavit of Compliance.

E. Signature_____

F. Company Name_____

G. Notary Public_____

H. _____County, State_____

I. My commission Expires:_____

1.5 TECHNOLOGY VENDOR REFERENCES

A. Include at least three references for similar projects.

1. Customer Name: _____
2. Address:_____
3. Contact Name: _____
4. Contact Title:_____
5. Phone: _____
6. E-Mail Address: _____
7. Date Started & Completed:_____
8. Dollar Amount of Project: _____
9. Comments:

   _____
   _____
   _____

10. Customer Name: _____
11. Address:_____
12. Contact Name: _____
13. Contact Title:_____
14. Phone: _____
15. E-Mail Address: _____
16. Date Started & Completed:_____
17. Dollar Amount of Project: _____
18. Comments:

    _____
    _____
    _____

19. Customer Name: _____
20. Address:_____
21. Contact Name: _____
22. Contact Title:_____
23. Phone: _____
24. E-Mail Address: _____
25. Date Started & Completed:_____
26. Dollar Amount of Project:_____
27. Comments:

    _____
    _____
    _____

1.6 CERTIFICATIONS AND BASE BID

A. Base Bid, Multiple-Prime (Single-Trades) Contract:

B. The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by AE Tech Design and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, including all scheduled allowances, necessary to complete the construction of each bid category below, Work for above-named Project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sums of:

1. Outside Plant Fiber Optic Cabling:
   a. Total
   b. _____ Dollars ($_____).

2. Copper Structured Cabling:
   a. Total
   b. _____ Dollars ($_____).

3. Network Electronics:
   a. Total
   b. _____ Dollars ($_____).

4. Video Surveillance:
   a. Total
   b. _____ Dollars ($_____).

5. Public Address:
   a. Total
   b. _____ Dollars ($_____).

6. Comments:
   _____
   _____
   _____

1.7 UNIT PRICES

A. The undersigned Bidder has reviewed the Unit Price requirements and agrees the amounts below shall be added to or deducted from the Contract Sum on performance and measurement of the individual items of Work. Refer to drawings for part and model numbers of devices.

B. Unit Price No. 1: To add or deduct one access point.
   1. _____ Dollars ($_____) per unit.

C. Unit Price No. 2: To add or deduct one ONT network device (In pole enclosure).
   1. _____ Dollars ($_____) per unit.

D. Unit Price No. 3: To add or deduct one PA speaker.
   1. _____ Dollars ($_____) per unit.

E. Unit Price No. 4: To re-run an existing copper network drop in the interior of city hall.
   1. _____ Dollars ($_____) per unit.

F. Unit Price No. 5: Cost per Foot to plow innerduct.
   1. _____ Dollars ($_____) per unit.

G. Unit Price No. 6: Cost per foot to directionally bore innerduct.
   1. _____ Dollars ($_____) per unit.

H. Unit Price No. 7: Cost per foot to pull new single mode fiber optic cabling.
   1. _____ Dollars ($_____) per unit.

I. Unit Price No. 8: To provide and install fiber handhole. Includes saw cutting and concrete repair where necessary.
   1. _____ Dollars ($_____) per unit.

1.8 BID GUARANTEE

A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 days after a written Notice of Award, if offered within 60 days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached cash, cashier's check, certified check, U.S. money order, or bid bond, as liquidated damages for such failure, in the following amount constituting five percent (5%) of the Base Bid amount above:
   1. _____ Dollars ($_____).

B. In the event Owner does not offer a Notice of Award within the time limits stated above, Owner will return to the undersigned the cash, cashier's check, certified check, U.S. money order, or bid bond.

1.9 SUBCONTRACTORS AND SUPPLIERS

A. The following companies are included as subcontractors under the Prime contractor for the portions of the Work indicated:
   1. Work Scope: _____Company_____
   2. Work Scope:_____ Company_____
   3. Work Scope: _____Comapny_____
   4. Work Scope: _____Company_____

1.10 TIME OF COMPLETION

A. The undersigned Bidder proposes and agrees hereby to fully complete the Work by December 29th, 2023.
   1. As a result of ongoing supply-chain disruptions and component shortages, this completion date remains flexible depending only on product availability.

1.11 ACKNOWLEDGEMENT OF ADDENDA

A. The undersigned Bidder acknowledges receipt of and use of the following Addenda (as issued) in the preparation of this Bid:
   1. Addendum No. 1, dated _____.
   2. Addendum No. 2, dated _____.

3. Addendum No. 3, dated _____.
4. Addendum No. 4, dated _____.

1.12 BID SUPPLEMENTS

A. The following supplements are a part of this Bid Form and are attached here to:
   1. Bid Form Supplement - Bid Bond Form (AIA Document A310) or bid security.
   2. Bid Form Supplement – Iran Sanctions Act.

1.13 SUBMISSION OF BID

A. Respectfully submitted this ____ day of _____, 2022.

B. Submitted By:_____
   1) (Name of bidding firm or corporation)

C. Authorized Signature:_____

D. Signed By:_____
   a) (Type or Printed name)

E. Title:_____

F. Street Address:_____

G. City, State, Zip:_____

H. Phone:_____

I. Federal ID No.: _____

END OF DOCUMENT 004123

SECTION 270000 - GENERAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Division 27 Specifications are established to define the standards, criteria and assumptions to be used to bid, plan, furnish, install, test and document various information transportation pathways and systems. These Specifications, along with the Drawings, form the basis for implementation of the design, installation, inspection and close-out process.

B. Division 27 is based on the latest editions of the NFPA 70 (NEC), the National Electrical Safety Code (NESC), the Institute of Electronic and Electrical Engineers (IEEE), the ANSI/TIA Telecommunications Standards, and BICSI methodologies. The requirements within those documents are not superseded herein unless specifically stated. As required, the NEC and NESC code requirements cannot be superseded by this document at any time. ANSI/TIA standards and BICSI methodologies may be superseded as specified or be made stricter by this document. The absence of a specific reference to an element of these codes, standards or methodologies does not relieve all parties of compliance with them. All parties must also adhere to requirements and permitting as established by the Authorities Having Jurisdiction (AHJ).

C. Contractor shall comply with all applicable codes and regulations.

D. Fire proofing: Clips, hangers, clamps and supports and other attachments to surfaces to be fireproofed shall be installed prior to start of spray fire proofing work. Patching and repairing of fireproofing due to cutting or damage to fireproofing during course of work specified under this section shall be performed by installer of fireproofing and paid for by section responsible for damage and shall not constitute grounds for an extra to Owner.

E. Fire stopping: See drawings to verify which Contractor is responsible of the initial installation of fire stopping required for this project. Any Contractor removing the fire stop for any reason is responsible to re-install fire stopping. It is the initially responsible Contractor’s responsibility to enforce this action or re-install the fire stopping.

F. Provide access panels and/or doors as required to allow service or inspection of all equipment components.

G. Carefully verify location, use, and status of all wiring, material, equipment and utilities that are specified, indicated, or deemed necessary for removal. Verify that all items to be removed are inactive, and will not be required after completion of the project. Replace, with no cost to the Owner, any wiring, material, equipment and utility removed that are required to be left in place.

1.2 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. Active Equipment: Electronic equipment used to develop various WAN, LAN, and voice services, e.g. digital multiplexers, RS-232 controllers, Ethernet hubs, switches, routers, PBX, etc.

C. ARC: Aluminum rigid conduit.

D. BICSI: Building Industry Consulting Service International.

E. BCT: Bonding conductor for telecommunications.

F. Bonding: Permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on it.

G. Building Backbone: Cabling system consisting of media and termination hardware interconnecting MDFs to IDFs.

H. Cable Tray: Vertical or horizontal open supports, usually made of aluminum or steel, which are fastened to the building structure. Cables are laid in and fastened to the trays.

I. Cabinet: Free standing, floor-mounted or wall-mounted modular enclosure designed to house and protect rack-mounted electronic equipment and passive terminations.

J. Backbone: Cabling system consisting of media and termination hardware interconnecting POE, Net-Pop's and Future onsite buildings.

K. Cross-Connect: Equipment enabling the termination of cable elements and their interconnection or cross-connection.

L. Cross-Connect Jumper: A cluster of twisted-pair conductors without connectors used to establish a circuit by linking two cross-connect termination points.

M. Demarc: The area where the outside plant media/carrier services appear in the facility. It contains equipment used by Owner or carrier to hand¬off/transition cable from outside plant to inside plant type.

N. EDID: Extended Display Identification Data - format for display devices to describe their capabilities to a video source.

O. EMI: Electromagnetic interference.

P. FTP: Shielded twisted-pair cable.

Q. F/FTP: Overall foil-screened cable with foil-screened twisted-pair.

R. FO: Fiber Optic cable.

S. F/UTP: Overall foil-screened cable with unscreened twisted-pair.

T. GRC: Galvanized rigid conduit.

U. Grounding: A conducting connection to earth, or to some conducting body that serves in place of earth.

V. Horizontal cabling: Cabling system consisting of media and termination hardware interconnecting the Telecommunication Outlets (TOs) and the IDFs.

W. HDBase-T: commercial connectivity standard for transmission of AV signals over a common category cable using the same modular connectors used by Ethernet.

X. HDCP: High-bandwidth Digital Content Protection – a form of digital copy protection.

Y. HDMI: High-Definition Multimedia Interface – proprietary digital AV interface.

Z. IDC: Insulation displacement connector.

AA. IMC: Intermediate metal conduit.

BB. Intermediate Distribution Frame (IDF): Location for the termination of backbone cables and horizontal cables, and for the interconnection of each. The space also hosts access-layer switches and user network connections within each floor.

CC. IP: Internet protocol.

DD. Jack: Receptacle used in conjunction with a plug to make contact between communications circuits, e.g., eight-position/eight-contact modular jacks. Also commonly called an “outlet”, fixed, female connector.

EE. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

FF. LAN: Local area network.

GG. Main Distribution Frame (MDF) Areas: Space in which Layer 2/3 network switching gear and other main network distribution equipment is housed and acts as the mid-connection point between the Core/Network and the IDF/access zones for all connections.

HH. MPEG: Moving picture experts group.

II. Outside Plant (OSP): Generally, any and all portions of the cable system that runs outside of an environmentally enclosed structure and/or building with each end terminated at different buildings. This specifically includes inter-building cables, conduits, manholes, hand-holes, and innerduct.

JJ. Passive Equipment: Non-electronic hardware and apparatus, e.g., equipment racks, cable trays, electrical protection, patch panels, wiring blocks, fiber optic shelves, etc.

KK. Patch Cord: A length of wire or fiber cable with connectors on one or both ends used to join communications circuits at a cross-connect.

LL. Patch Panel: A system of terminal blocks or connectors used with patch cords that facilitate administration of cross-connect fields.

MM. Pathway: Facility for the placement of communications cable that may be composed of several components including conduit, wireway, cable tray, surface raceway, under floor systems, overhead systems, raised floor, ceiling support wires, etc.

NN. PC: Personal computer.

OO. Plug: Also commonly called a “connector”; it is the removable male telecommunications connector.

PP. Protectors: Electrical protection devices used to limit foreign voltages on communications circuits.

QQ. Provide: Furnish, install, terminate, label, test and certify a complete operating cabling system.

RR. PTZ: Pan-tilt-zoom.

SS. Raceway: An enclosed channel designed expressly for holding wires or cables; may be of metal or insulating material. The term includes conduit, tubing, wire ways, under floor raceways, overhead raceways and surface raceways; does not include cable tray.

TT. Racks: An open, freestanding, floor-mounted structure, typically made of aluminum or steel, used to mount equipment; usually referred to as an equipment rack.

UU. RAID: Redundant array of independent disks.

VV. RCDD: Registered Communications Distribution Designer.

WW. RTRC: Reinforced thermosetting resin conduit.

XX. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

YY. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

ZZ. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

AAA. S/FTP: Overall braid screened cable with foil screened twisted pair.

BBB. S/UTP: Overall braid screened cable with unscreened twisted pair.

CCC. Structured Cabling System (SCS): Required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP and fiber cable installed and configured to provide computer data and voice connectivity.

DDD. TCP: Transmission control protocol - connects hosts on the Internet.

EEE. Telecommunication Outlet (TO): Connecting device mounted in a work area used to terminate horizontal cable and interconnect cabling with station equipment.

FFF. TGB: Telecommunications grounding busbar.

GGG. TMGB: Telecommunications main grounding busbar.

HHH. UPS: Uninterruptible power supply.

III. USB: Universal Serial Bus – industry standard for cables, connectors, and protocols of low power devices.

JJJ. USB-IF: USB Implementers Forums – organization that maintains the USB specification and compliance program.

KKK. UTP: Unscreened (unshielded) twisted pair cable.

LLL. WAN: Wide area network.

MMM. Wireless Access Point (WAP): Telecom outlet designated for use with wireless network devices. Such outlet shall be mounted above ceiling.

NNN. Work Area Subsystem: The connection between the telecommunications outlet and the station equipment in the work area; consisting of cords, adapters, and other transmission electronics.

1.3 CLOSEOUT SUBMITTALS

A. Operation, Software, Firmware, and Maintenance Data: For all equipment and systems to include in operation and maintenance manuals.

B. Each related section referenced in the Specifications may have its own requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: See specific Division 27 Specifications and Drawings for Manufacturer qualifications.

B. Installer Qualifications: See specific Division 27 Specifications and Drawings for Installer qualifications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall be responsible for the delivery, storing, and handling of all materials relative to the systems, including material supplied by others that are part of the contract installation. Material shall be stored and protected per manufacturers' instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortage, damage, or loss due to storage and handling methods.

1.6 FIELD CONDITIONS

A. Contractor shall verify all field conditions and dimensions that affect selection, provision and installation of materials and equipment; and shall provide any disassembly, reassembly, relocation, demolition, cutting, and patching required to work specified or indicated, including relocation and reinstallation of existing wiring and equipment. Contractor shall protect the existing facility, equipment and wiring from damage resulting from the Contractor's operations. Extra charges for completion and contract time extension will not be allowed because of field conditions or additional work required for complete and usable construction and systems. Do not interrupt utilities serving facilities.

1.7 WARRANTY

A. Warranty: Installer agrees to repair or replace any component that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

2. Verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

B. Special Warranty: Include only in those Sections where availability has been verified with Contractors and Manufacturers listed.
1. If Installer is included as signer of the warranty, the maximum warranty period that sureties will allow is two years. Use specified form of special warranty only when it is included at the end of the Section.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. See specific Specifications and Drawings for materials and components required for this project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine site, review Specifications and Drawings, and determine exact extent of work required prior to submitting a proposal.

B. Questions regarding the intent of Specifications and Drawings, quality of materials to be used and work to be performed, shall be submitted in writing to Owner’s Representative. All answers and clarifications will be issued in writing.

3.2 FIELD QUALITY CONTROL

A. Testing Agency: See specific Specifications and Drawings for individual testing requirements.

B. Products will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports as required in Specifications and Drawings.

3.3 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

END OF SECTION 270000

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

2.3 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products manufacturers as indicated on the drawings.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. TGB: Predrilled rectangular bars of hard-drawn solid copper as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-C.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller thanNo. 8 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install barecopper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.5 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller thanNo. 8 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

F. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

G. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

H. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

I. Access Floors: Bond all metal parts of access floors to the TGB.

J. Equipment Room Signal Reference Grid: Provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.6 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

B. Comply with IEEE C2 grounding requirements.

C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Tele-power poles.
9. Hooks.
10. Boxes, enclosures, and cabinets.
11. Polymer-concrete handholes and boxes for exterior underground cabling.
12. Fiberglass handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270529 “Hangers and Supports for Communications Systems”
3. Section 270543 “Underground Pathways and Structures for Communication Systems”
4. Section 270544 “Sleeves and Sleeve Seals for Communications Systems”

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.3 ACTION SUBMITTALS

A. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Set screw.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Comply with TIA-569-D.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651A.

F. RTRC: Comply with UL 2515A and NEMA TC 14.

G. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for general-use installation unless otherwise indicated.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Screw-cover type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

B. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

C. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Finish: Manufacturer's standard enamel finish in color selected by Architect or Owner.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.7 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Finish: Texture and color selected by Architect from manufacturer's standard colors.

C. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.8 TELE-POWER POLES:

A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.

B. Material: Aluminum with clear anodized finish.

C. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.9 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. J shape.

2.10 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1,Type FD, with gasketed cover.

E. Metal Floor Boxes:
1. Shape: Rectangular.
2. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes:

1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

a. Material: Plastic or Fiberglass.
b. Finished inside with radio-frequency-resistant paint.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box, unles otherwise indicated, with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.11 POLYMER-CONCRETE HANDHOLES

A. Description: Molded of sand and aggregate; bound together with polymer resin; and reinforced with steel, fiberglass, or a combination of the two.

B. General Requirements for Polymer Concrete Handholes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D and SCTE 77.

C. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

1. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
2. Cover Legend: Molded lettering.

E. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.12 FIBERGLASS HANDHOLES AND BOXES

A. Description: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.

B. General Requirements for Fiberglass Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D and SCTE 77.

C. Configuration: Designed for flush burial with open bottom unless otherwise indicated.

D. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

F. Cover Legend: Molded lettering.

G. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.13 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: IMC.
2. Concealed Conduit, Aboveground: IMC or EMT.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried, unless otherwise indicated.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT or RNC.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums

e. Shop / industrial areas.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT or innerduct.
5. Damp or Wet Locations: IMC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, communications-cable pathway.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, communications-cable pathway.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use set-screw or compression, steel fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

I. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to RNC, Type EPC-40-PVC, or IMC and fittings before rising above floor.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

O. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

P. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

Q. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

R. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

S. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

T. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

V. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

W. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

CC. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

FF. Set metal floor boxes level and flush with finished floor surface.

GG. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 for pipe of less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 31.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31.
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete around conduit for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, but a minimum of 6 inches below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 270553 "Identification for Communications Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07.

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Steel slotted support systems for communication raceways.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

B. Related Requirements:
1. Section 270000 “General Requirements for Communications”

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Plain steel.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   2. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: Stainless-steel springhead type.
   7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
   1. NECA 1.
   2. NECA/BICSI 568.
   3. TIA-569-D.
   4. NECA 101
   5. NECA 102.
   6. NECA 105.
   7. NECA 111.

B. Comply with requirements in Division 07 for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with single-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC and RMC may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Use expansion anchor fasteners.
   5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
   7. To Light Steel: Sheet metal screws.
   8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 270529

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wire-mesh cable tray.
   2. Cable tray accessories.
   3. Warning signs.

B. Related Requirements:
   1. Section 270000 “General Requirements for Communications”
   2. Section 270529 “Hangers and Supports for Communications Systems”

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
   1. Temperature Change: 120 deg F, ambient; 180 deg F (100 deg C), material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
   1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
   2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
   3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-MESH CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. Description:

1. Configuration: steel wire mesh, complying with NEMA VE 1.
2. Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 2 inches unless otherwise indicated on Drawings.
4. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
5. Splicing Assemblies: Bolted type using serrated flange locknuts.
6. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:
1. Steel:
a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1008/A 1008M, Grade 33, Type 2.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
1) Hardware: Galvanized, ASTM B 633.

2.4 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Fasten cable tray supports to building structure.

F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."

G. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support bus assembly to prevent twisting from eccentric loading.

J. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

K. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

L. Support wire-basket cable trays with wall brackets unless indicated otherwise on the Drawings.

M. Support center support hangers for wire-basket trays with 3/8-inch- diameter rods.

N. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

O. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

P. Make changes in direction and elevation using manufacturer's recommended fittings.

Q. Make cable tray connections using manufacturer's recommended fittings.

R. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

S. Install cable trays with enough workspace to permit access for installing cables.

T. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

U. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

V. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays not less than every 60 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.

2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 270543 - UNDERGROUND PATHWAYS AND STRUCTURES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduit and fittings, including GRC and PVC-coated GRC.
2. Rigid nonmetallic duct.
3. Duct accessories, including rigid innerduct and fabric innerduct.
4. Polymer concrete handholes and boxes with polymer concrete cover.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270526 “Grounding and Bonding for Communications Systems”

1.2 DEFINITIONS

A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid conduit.

E. IMC: Intermediate metal conduit.

F. RNC: Rigid nonmetallic conduit.

G. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

B. Source quality-control reports.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.5 FIELD CONDITIONS

A. Interruption of Existing Communications Service: Do not interrupt communications service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary communications service according to requirements indicated:

1. Notify Owner no fewer than14 days in advance of proposed interruption of communications service.
2. Do not proceed with interruption of communications service without Owner's written permission.

B. Ground Water: Assume ground-water level is 36 inches below ground surface unless a higher water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. PVC-Coated Steel Conduit: PVC-coated IMC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

C. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

2.2 RIGID NONMETALLIC DUCTS

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Underground Plastic Utilities Duct: Type DB-60-PVC RNC, complying with NEMA TC 6 & 8 and with ASTM F-512 for direct burial, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

C. Underground Plastic Utilities Duct: Type EB-20 PVC RNC, complying with NEMA TC 6 & 8, ASTM F-512, and UL 651, with matching fittings complying with NEMA TC 9 by same manufacturer as duct.

D. General Requirements for Nonmetallic Ducts and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

E. Solvents and Adhesives: As recommended by duct manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS

A. HDPE Duct: Type EPEC 40-HDPE complying with NEMA TC 7 and UL 651A.
1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

2.4 DUCT ACCESSORIES

A. Rigid Innderduct: Corrugated HDPE duct, orange in color, designed for installation within a duct or pathway.

B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

C. Underground-Line Warning Tape: Underground-line warning tape specified in Section 270553 "Identification for Communications Systems."

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

D. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "COMMUNICATIONS."

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes24 inches wide by 36 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

A. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Designer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Communications: Type EPC-40-PVC RNC, in concrete-encased duct bank unless otherwise indicated.

B. Duct for Communications: Type EPC-40-PVC RNC, in direct-buried duct bank unless otherwise indicated.

C. Duct for Communications: Type EPEC-40-HDPE duct in direct-bored duct bank unless otherwise indicated.

D. Underground Duct Crossing Roadways: Type EPC-40-PVC RNC, encased in reinforced concrete.

E. Stub-Ups for Communications: Concrete-encased RNC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for Communications:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer concrete units, SCTE 77, Tier 8 structural load rating.
4. Cover design load shall not exceed the design load of the handhole or box.

3.4 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area after construction in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Install duct and duct bank according to NEMA TCB 2 and TIA-758-B.

B. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.

C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.

D. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.

E. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

F. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

G. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

H. Innerduct: Install immediately after mandreling duct. Size and type as indicated on Drawings.

I. Pulling Cord: Install 200-lbf- test nylon cord in empty duct and innerduct.

J. Concrete-Encased Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct or duct bank. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
3. Depth: Install top of duct and duct bank at least 36 inches below finished grade in areas not subject to deliberate traffic, and at least 42 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
4. Support duct and duct bank on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
6. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct run unless otherwise indicated. Extend concrete encasement throughout length of elbow.

7. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
8. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
9. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between ducts, and 4 inches between power and communications duct.
10. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

11. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

K. Direct-Buried Duct and Duct Banks:

1. Excavate trench bottom to provide firm and uniform support for duct and duct bank. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for duct less than 6 inches in nominal diameter.
2. Install duct with a minimum of 3 inches between duct for like services and 6 inches between power and signal duct.
3. Width: Excavate trench 12 inches wider than duct or duct bank on each side.
4. Depth: Install top of duct or duct bank at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct or duct bank below frost line.
6. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around duct or duct bank.
8. Elbows: Install manufactured duct elbows for stub-ups, at building entrances through floor, and at changes of direction in duct unless otherwise indicated. Encase elbows for stub-ups throughout length of elbow..

9. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving duct at end of run free to move with expansion and contraction, as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around duct to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
   a. Place minimum of 6 inches of engineered fill above concrete encasement of duct bank.

L. Underground-Line Warning Tape: Bury underground-line warning tape specified in Section 270553 "Identification for Communication Systems" no less than 12 inches above all concrete-encased duct and duct bank and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct and duct bank, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, 36 inches below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.7 GROUNDING

A. Ground underground duct, duct bank, and utility structures according to Section 270526 "Grounding and Bonding for Communications Systems."

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch- long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 270526 "Grounding and Bonding for Communications Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION 270543

SECTION 270544 - SLEEVES AND SLEEVE SEALS FOR COMMUNICATIONS PATHWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.

b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

   a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07.
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in

annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 270544

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

B. Related Requirements:
1. Section 270000 “General Requirements for Communications”

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-C.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:
1. Black letters on a white field.

2.3 LABELS

A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, flexible labels with acrylic pressure-sensitive adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Brady Corporation.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

B. Self-Adhesive Labels: thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:
a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

C. Tag: Type I:
1. Pigmented polyolefin, bright colored,compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 4 mils.
4. Weight: 18.5 lb/1000 sq. ft..
5. Tensile according to ASTM D 882: 30 lbf and 2500 psi.

D. Tag: Type II:
1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored,compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 12 mils.
4. Weight: 36.1 lb/1000 sq. ft..
5. Tensile according to ASTM D 882: 400 lbf and 11,500 psi.

E. Tag: Type ID:
1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored,compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft..
6. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

F. Tag: Type IID:
1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored,compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 8 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 34 lb/1000 sq. ft..
6. Tensile according to ASTM D 882: 300 lbf and 12,500 psi.

2.5 SIGNS

A. Baked-Enamel Signs:
1. Preprinted aluminum signs,punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:
1. Engraved legend.
2. Thickness:
a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch thick.
c. Engraved legend with black letters on white face.
d. Self-adhesive.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Self-Adhesive Wraparound Labels:
   1. Secure tight to surface at a location with high visibility and accessibility.
   2. Provide label 6 inches from cable end.

I. Self-Adhesive Labels:
   1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.

J. Underground-Line Warning Tape:
   1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
   2. Install underground-line warning tape for direct-buried cables and cables in raceways.

K. Cable Ties: General purpose, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.
   1. System legends shall be as follows:
      a. Telecommunications.
      b. CATV.
      c. Optical Fiber.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, as indicated on the Drawings.

E. Equipment Room Labeling:
   1. Racks, Frames, and Enclosures: Identify front of each with self-adhesive labels.
   2. Patch Panels: Label individual rows and outlets, as indicated on the Drawings, with self-adhesive labels.
   3. Data Outlets: Label each outlet with a self-adhesive label as indicated on the Drawings

F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a self-adhesive wraparound label as indicated on the Drawings.

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
   1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:
   1. Indoor Equipment: Self-adhesive label.
   2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
   3. Equipment to Be Labeled:
      a. Communications cabinets.
      b. Uninterruptible power supplies.
      c. Computer room air conditioners.
      d. Power distribution components.

END OF SECTION 270553

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backboards.
2. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270536 "Cable Trays for Communications Systems"
3. Section 271323 "Communications Optical Fiber Backbone Cabling"
4. Section 271513 "Communications Copper Horizontal Cabling"
5. Section 271523 "Communications Optical Fiber Horizontal Cabling"

1.2 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. RCDD: Registered communications distribution designer.

D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

E. TGB: Telecommunications grounding bus bar.

F. TMGB: Telecommunications main grounding bus bar.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Backboard Paint: Light-colored fire-retardant paint.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

I. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box unless otherwise indicated, with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for all pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

F. Backboards:

1. Install from 36 inches to 7 feet, 36 inches above finished floor.
2. Paint all sides of backboard with two coats of paint.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Comply with requirements in Division 07.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 19-inch freestanding and wall-mounted equipment cabinets.
3. Grounding.

B. Related Requirements:

1. Section 270000 “Genera, Requirements for Communications”
2. Section 270526 "Grounding and Bonding for Telecommunications Equipment"
3. Section 270536 "Cable Trays for Communications Systems"
4. Section 271100 “Communications Equipment Room Fittings”
5. Section 271323 "Communications Optical Fiber Backbone Cabling"
6. Section 271513 "Communications Copper Horizontal Cabling"
7. Section 271523 "Communications Optical Fiber Horizontal Cabling"

1.2 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

F. TGB: Telecommunications grounding bus bar.

G. TMGB: Telecommunications main grounding bus bar.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
   2. Field Inspector: Currently registered by BICSI as Technician to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 06.

2.2 19-INCH EQUIPMENT RACKS

A. Description: Two- and four- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. General Requirements:

   1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   2. Material: Steel.
   3. Finish: Manufacturer's standard, baked-polyester powder coat.
   4. Color: Black.

C. Floor-Mounted Racks:

   1. Overall Height: As indicated on Drawings.
   2. Overall Depth: As indicated on Drawings.
   3. Number of Rack Units per Rack: As indicated on Drawings.
   4. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug.
   5. Base shall have a minimum of four mounting holes for permanent attachment to floor.
   6. Top shall have provisions for attaching to cable tray or ceiling.
   7. Self-leveling.

D. Wall-Mounted Racks:

   1. Height: As indicated on Drawings.
   2. Depth: As indicated on Drawings.
   3. Number of Rack Units per Rack: As indicated on Drawings.
   4. Wall Attachment: Minimum of four mounting holes.
   5. Equipment Access: Integral swing.

2.3 19-INCH EQUIPMENT CABINETS

A. Description: Manufacturer-assembled four-post frame enclosed by side and top panels and front and rear doors, designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72 inches between rails.

B. General Cabinet Requirements:

1. Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Modular Freestanding Cabinets:

1. Overall Height: As indicated on Drawings.
2. Overall Depth: As indicated on Drawings.
3. Number of Rack Units: As indicated on Drawings.
4. Removable and lockable side and top panels.
5. Hinged and lockable front and rear doors.
6. Adjustable feet for leveling.
7. Cable access provisions in roof and base.
8. TGB.
9. All cabinets keyed alike.

D. Modular Wall Cabinets:

1. Height: As indicated on Drawings.
2. Depth: As indicated on Drawings .
3. Number of Rack Units: As indicated on Drawings.
4. Lockable front doors.
5. Cable access provisions top and bottom.
6. Grounding lug.
7. All cabinets keyed alike.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 6 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

A. Comply with requirements in Division 09 for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. Labels shall be machine printed. Type shall be a minimum of 1/8 inch in height.

END OF SECTION 271116

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
2. 9/125 micrometer single-mode, inside plant optical fiber cable (OS2).
3. 9/125 micrometer single-mode, outside plant optical fiber cable (OS2).
4. Optical fiber cable connecting hardware, patch panels, and cross-connects.
5. Cabling identification products.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270528 “Pathways for Communications Systems”
3. Section 270529 "Hangers and Supports for Communications Systems”
4. Section 270536 "Cable Trays for Communications Systems”
5. Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling”
6. Section 270553 "Identification for Communications Systems”

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.3 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
   2. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, loose tube, armored optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Riser Rated, Nonconductive: Type OFNR or Type OFNP, complying with UL 1666.
3. Plenum Rated, Armored (Conductive): Type OFCP, complying with NFPA 262.

2.3 9/125 MICROMETER SINGLE-MODE, INSIDE PLANT OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, loose tube, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-83-596 for mechanical properties.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2. Riser Rated, Nonconductive: Type OFNR or Type OFNP, complying with UL 1666.

2.4 9/125 MICROMETER SINGLE-MODE, OUTSIDE PLANT OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, loose tube, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, provide products manufacturers as indicated on the drawings.

C. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-87-640 for mechanical properties.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Black.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.5 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field.

D. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths unless noted otherwise.

E. Connector Type: Type LC complying with TIA-604-10-B, connectors.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-C.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Division 07.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-C and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 6 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 8 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, and workstation terminal positions.

D. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271323

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Category 6 twisted pair cable.
2. Category 6a twisted pair cable.
3. Twisted pair cable hardware, including plugs and jacks.
4. Cable management system.
5. Cabling identification products.
6. Grounding provisions for twisted pair cable.
7. Source quality control requirements for twisted pair cable.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270529 “Hangers and Supports for Communications Systems”
3. Section 270544 “Sleeves and Sleeve Seals Communications Pathways and Cabling”

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Technology closets and the equipment outlet in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   2. Bridged taps and splices shall not be installed in the horizontal cabling.

B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD, Installer, installation supervisor, and field inspector.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. As-built Drawings: For identification of horizontal cabling labels.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

   1. Test each pair of twisted pair cable for open and short circuits.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-C.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed cable routing assembly.
2. Communications, Non-plenum: Type CMR complying with UL 1666 and ICEA S-103-701.

B. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: As indicated on the drawings.

G. Jacket Color: As indicated on the drawings.

2.4 CATEGORY 6a TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Standard: Comply with TIA-568-C.2 for Category 6a cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: As indicated on the drawings.

G. Jacket Color: As indicated on the drawings.

2.5 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

E. Connecting Blocks:
1. 110-style IDC for Category 6.
2. Provide blocks for the number of cables terminated on the block.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.

d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

G. Patch Cords: Factory-made, four-pair cables in12 inch lengths unless noted otherwise on the drawings; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

J. Faceplate:
1. Plastic Faceplate: High-impact plastic. Coordinate color with Owner / Architect.
2. Metal Faceplate: Stainless steel.
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 CABLE MANAGEMENT SYSTEM

A. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.

B. Information shall be presented in technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

C. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.7 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-C.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270528 "Pathways for Communications Systems."

C. Comply with Section 270529 "Hangers and Supports for Communications Systems."

D. Comply with Section 270536 "Cable Trays for Communications Systems."

E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted-pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable10 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Division 07.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-C and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 6 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 8 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, and workstation terminal positions.

C. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

D. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Report must be submitted prior to request for Substantial Completion Inspection. Any corrections identified by the Designer during the inspection are to be completed before Substantial Completion will be granted.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION 271513

SECTION 271523 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
3. Grounding.
4. Cabling identification products.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270528 “Pathways for Communications Systems”
3. Section 270529 “Hangers and Supports for Communications Systems”
4. Section 270536 “Cable Trays for Communications Systems”
5. Section 270544 “Sleeves and Sleeve Seals Communications Pathways and Cabling”
6. Section 270553 “Identification for Communications Systems”

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.4 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system shall provide interconnections between Technology closets and the equipment outlet in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
2. Bridged taps and splices shall not be installed in the horizontal cabling.

INFORMATIONAL SUBMITTALS

B. Qualification Data: For RCDD, Installer, , installation supervisor, and field inspector.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

B. As-built Drawings: For identification of horizontal cabling labels.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
1. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.9 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered, nonconductive optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

C. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

D. Jacket:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

E. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

F. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2.3 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field.

D. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths unless noted otherwise on the drawings.

E. Connector Type: Type LC complying with TIA-604-10-B, connectors.

F. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

H. Faceplate:
1. Plastic Faceplate: High-impact plastic. Coordinate color with Owner / Architect.
2. Metal Faceplate: Stainless steel.
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-C.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301 and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot- long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07.

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-C and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

B. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, and workstation terminal positions.

C. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for horizontal links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271523

SECTION 274100 - AUDIO-VIDEO SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:
   1. AV devices.
   2. AV cable and cable hardware.

B. Related Requirements:
   1. Section 270000 “General Requirements for Communications”
   2. Section 270529 “Hangers and Supports for Communications Systems” for supporting AV cabling.
   3. Section 270544 “Sleeves and Sleeve Seals for Communications Pathways and Cabling” for new pathways connecting devices.
   4. Section 271513 “Communications Copper Horizontal Cabling” for all category cabling and patch cords.

1.3 DEFINITIONS

A. EDID: Extended Display Identification Data - format for display devices to describe their capabilities to a video source.

B. HDBase-T: commercial connectivity standard for transmission of AV signals over a common category cable using the same modular connectors used by Ethernet.

C. HDCP: High-bandwidth Digital Content Protection – a form of digital copy protection.

D. HDMI: High-Definition Multimedia Interface – proprietary digital AV interface.

E. USB: Universal Serial Bus – industry standard for cables, connectors, and protocols of low power devices.

F. USB-IF: USB Implementers Forums – organization that maintains the USB specification and compliance program.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For AV Systems to include in operation and maintenance manuals.

B. As-Built Drawings:
1. Create in CAD software.
2. Show cable identification for each internal system cable.
3. Show final as-built system diagrams with manufacturer, make and model of devices.
4. Provide on digital media (as PDF or DXF files) and in printed copy.

C. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
2. Program Software Backup: On digital media, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
1. Comply with requirements in Section 271513 “Communications Copper Horizontal Cabling” for all category cabling and patch cords.

B. Mockups: Build mockups to demonstrate aesthetic effects, to set quality standards for fabrication and installation, and to perform testing.
1. Build mockup of any/all AV system(s) in which there are more than (2) two of that system type shown on Drawings.
2. Approval of mockups do not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of AV systems that fail(s) in materials or workmanship within specified warranty period.
1. Warranty Period: Minimum of one year(s) from date of Substantial Completion. If Manufacturer warranty is greater than one year, then Manufacturer will honor full term of warranty.

PART 2 - PRODUCTS

2.1 AV DEVICES

A. All AV Devices must:
1. Reproduce video and audio signals that are clear and free of hum, noise, or other distortion.

2. Communicate proper EDID information between devices. If required EDID emulation devices shall be utilized to ensure EDID conformity.
3. Use cables, adapters, o/andr accessories capable of supporting HDCP v1.1 when connecting to devices that utilize HDCP.

B. HDBase-T devices must be:.
1. Certified by the HDBase-T Alliance.
2. Capable of providing 4K Ultra-HD resolution at the installed distance between devices.
3. HDBase-T Class A when distance between devices exceeds Class B (aka HDBase-T Lite) specification, or where transmission of Ethernet via the HDBase-T device is required.

C. HDMI Devices must be:
1. Certified for HDMI v1.4 or greater.

D. Color: As indicated on Drawings..
1. Coordinate final color selection with Owner prior to ordering.

2.2 AV CABLE AND CABLE HARDWARE

A. Cable Manufacturers:
1. Must be supplied by listed Manufacturers or have equal specifications to those:
   a. Kramer Electronics USA
   b. Extron Electronics
   c. Comprehensive Connectivity Company

B. HDBase-T cable must meet the following criteria:
1. Cabling must be certified in the HDBase-T Alliance Recommended Cable Program.

C. USB cable must meet the following criteria:
1. USB 2.0 High Speed certified by USB-IF.

D. Analog Audio Cable must meet the following criteria:
1. Speaker cable must be 18/2 stranded, with shield and drain wires.
2. Generic audio cable must be a minimum of 22/2 stranded wire.

E. Patch Cords:
1. All A/V patch cords needed to provide a complete and functional installation are required. This includes audio, video, and data cables for Contractor and Owner supplied A/V equipment; but does not include cables connecting devices to other system, like the data network.

F. Connectors:
1. Connectors are to be factory installed. Field terminated connectors are not allowed.

G. Faceplates:
1. Faceplates to be plastic unless indicated otherwise.
2. Color to match existing electrical faceplates unless indicated otherwise. Coordinate final color selection with Owner prior to ordering.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of surface-mount raceway to verify actual locations of connections before equipment installation.

C. Examine walls for suitable conditions where large flat panels will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF AV CABLES

A. Comply with NECA 1.

B. Comply with TIA-568-C.0 and TIA-568-C.1.

C. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 “Penetration Firestopping.”

3.4 CONFIGURATION OF DEVICES

A. Control Systems:
   1. Control systems should be configured to control the following:
      a. Display device power (on/off), synchronous with power on/off of AV system.
      b. Motorized screen activation, synchronous with power on/off of AV system.
      c. Display source selection.
      d. Master Audio volume (up/down/mute).
   2. Review functionality and layout of control systems with Owner prior to programming devices.

B. HDBase-T Devices:
   1. When not used in conjunction with a control system (button panel, touch screen, etc.), ALL HDBase-T transmitting devices should be programmed to:

a. Power on the display device and switch to the appropriate source when an input device is connected.
b. Wait 60 seconds, then power down display device when all input devices are disconnected.

2. Review functionality of HDBase-T devices with Owner prior to programming devices.

C. Audio Devices:
1. Speakers: Speakers should be aimed to provide appropriate coverage for the space in which they are installed. Adjust relative volume levels of speakers to provide a consistent volume level for the audience seated in the space.
2. Equalization: Adjust equalization settings to accommodate room acoustics using reference signal and spectrum analyzer or other industry accepted test equipment.
3. Input Levels: Adjust and balance input levels at each source to provide consistent output volume levels between sources.
4. Audio Enhancement: Audio Enhancement system to remain operational while the rest of the AV system is powered down.
5. Wireless Microphones:
a. Coordinate the assignment of wireless microphone channels for each system to avoid conflicts with other wireless equipment including any existing or Owner provided microphones.
6. Lock channels to prevent accidental reconfiguration.

3.5 IDENTIFICATION

A. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
3. Labels shall be preprinted or computer printed type.
4. Labels shall be self-laminating cable-wrap style.

B. Device Labeling:
1. Label the front panel controls of all devices indicating their function.
a. Indicate typical volume, balance, and mixing levels.
b. Identify each source.
2. Label all wireless microphones with the room number and channel to which they are assigned.

3.6 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

3.7 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system, new or revised licenses for using software, and firmware for devices.
   1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain units.

END OF SECTION 274100

SECTION 275100 - DISTRIBUTED AUDIO-VIDEO COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Announcement Controllers
2. IP Audio-Visual Endpoints
3. IP-to-Analog Gateways
4. Analog Power Mixers/Amplifiers
5. Analog Speakers
6. Speaker Mounting Hardware
7. Duress Buttons
8. Cable and Cable Hardware

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”
2. Section 270529 "Hangers and Supports for Communications Systems" for
3. Section 270544 “Sleeves and Sleeves Seals for Communications Pathway and Cabling”
4. Section 271513 “Communications Copper Horizontal Cabling”

1.3 DEFINITIONS

A. dB: Decibel - a unit of measurement used to express the ratio of one value of a power or field quantity to another on a logarithmic scale.

B. IP: Internet Protocol - the principal communications protocol in the Internet protocol suite for relaying datagrams across network boundaries.

C. LAN: Local Area Network - computer network that interconnects computers within a limited area such as a single building.

D. POE: Power over Ethernet - system which passes electric power along with data on twisted pair Ethernet cabling.

E. THD: Total Harmonic Distortion - a measurement of the harmonic distortion present in a signal.

F. UTP: Unshielded Twisted Pair - UTP cable is the most common cable used in computer networking.

G. WAN: Wide Area Network - telecommunications network that extends over a large geographical distance for the primary purpose of computer networking.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For Distributed Audio-Video Comunications Systems to include in operation and maintenance manuals.

B. As-Built Drawings:

1. Create in CAD software.
2. Show cable identification for each internal system cable.
3. show final as-built system diagrams with manufacturer, make, and model of devices.
4. Provide on digital media (as PDF or DXF files) and in printed copy.

C. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On digital media, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of Distributed Audio-Video Communications Systems that fail(s) in materials or workmanship within specified warranty period.

1. Warranty Period: one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Design Requirements

1. Components of the Distributed Audio-Video Communications System shall provide a complete system IP-based solution for a fully functioning Public Address System, Emergency Notification System and Master Clock System for the project.
2. System shall include software from a single manufacturer for complete control and monitoring of the system for a full supported system.
3. System shall be digital and operate over the LAN and WAN, with redundancy as shown on contract documents.
4. System shall be capable of being configured and controlled remotely via Owner provided connectivity.
5. System shall include General Purpose input and output (GPIO) trigger points for interfacing to other systems including emergency and security systems, to provide event driven configuration scenarios for the system.
6. Each endpoint shall be a zone on the system capable of individual intercom use or as part of a zone group or all call during public address system use.
7. IP Endpoints shall use IEEE 802.3 standard PoE implementation so that they can be used with any IEEE 802.3af (PoE) or IEEE 802.3at (PoE+) 10/100Base-T switches.
8. IP Endpoints shall be Cisco IVT (Interoperability Verifications Test) Certified ensuring quality integration with Cisco products while not adversely affecting Cisco product operation.
9. System shall provide multicast or hybrid unicast/multicast for configuration of LAN and WAN with standard Ethernet protocols.
10. System shall be capable of operation with multiple telephone systems manufacturers.
11. System shall provide opening tones for announcements to speakers and scrolling text messages sent to displays.
12. System shall be Common Alerting Protocol (CAP) compliant to provide automated warning notifications for subscription alerts, such as weather and amber.
13. System shall be compliant with NEMA Standard SB-40 (Communications for Life Safety in Schools).

B. Functional Requirements

1. System operation shall allow administrator to define user privileges, define loudspeaker zones, pre-recorded messages, bell schedules, bell designations, event logs, background music streams, system configuration and endpoint status.
2. Manages dynamic requests for live, delayed and prerecorded messages (simple and assembled), record and playback of ad hoc messages, text-to-speech, mute actions (by zone or zone group) and two-way full duplex intercom connections.
3. Announcements and messages shall be initiated by contact closures; microphone paging stations; VoIP Phone Systems; or Wi-Fi Smartphones, tablets, and computers using open standard IP based protocols.
4. Includes a built-in comprehensive message / bell scheduling system that allows the creation of schedule profiles that can be applied to specific days of the week or date ranges. Multiple profiles can be applied simultaneously.
5. Any authorized individual shall be able to call from outside the facility into any room, zone, or entire building directly via the Owner supplied SIP enabled telephone network. This shall allow remote monitoring, call-in annunciation, and two-way conversation from outside the facility as well as paging into the system.
6. The system shall provide room occupants the ability to confirm that they have heard and executed the required instructions of any emergency announcement. Conformation shall be achieved by utilizing call button or desktop client notification interface. The authorized administrator can view real-time rooms state of either safely secured or non-secured via web-based user interface, both on-site and remotely. Authorized administrator shall be able to initiate two-way communication, without a pre-announcement tone, to the room.

7. The system shall provide supervision and logging for all associated end-point devices on the network with built-in E-mail / SMS notification & SNMP capabilities & Active Failover.
8. The system shall allow push notifications to unlimited number of IP Endpoints using VoIP Network Architecture.

2.2 ANNOUNCEMENT CONTROLLER

A. The announcement controller shall manage announcements and messages using dynamically routed data on a standard Ethernet Network. It shall include an integral multi-channel message server providing simultaneous record and playback capability for up to 16 play and 16 record channels (model dependent) in multiple languages.

B. The announcement controller shall manage peripherals including Digital Communications Stations, Network Power Amplifier Systems, Input/Output Devices, Zone Controllers and IP End Points. The announcement controller shall include internal support for a reasonable amount of logic inputs, relay outputs, and balanced audio inputs.

C. The announcement controller shall manage dynamic requests for live and delayed announcements, pre-recorded and assembled messages, actions, defined events, and two-way full duplex intercom connections. An integrated visual paging server shall deliver visual messaging to supported visual displays that shall be synchronized to the audio regardless of message length. Announcements and messages shall be initiated by contact closures, microphone paging stations, management software, open standard IP network commands, VoIP, or Wi-Fi Smartphones.

D. The announcement controller shall manage emergency alert software room occupant confirmation for critical announcements by utilizing existing call buttons or desktop client notification interface. Critical Announcements and messages requiring confirmation shall be initiated by contact closures, microphone paging stations, management software, open standard IP network commands, web-based user interface, VoIP, or Wi-Fi Smartphones.

E. The announcement controller shall include an integral interface for VoIP telephones via SIP and PBX trunking as well as standard 3rd party FXO gateways. The interface shall support standards G.711, G.722 and RTP protocols. Operating modes shall provide for both direct dial zone paging access and well as voice prompted actions for announcements and messages.

F. The announcement controller shall supervise all associated end-point devices, report system abnormalities, and log faults to be reported via SMNP, E-mail, and SMS via E-mail notifications.

G. The announcement controller shall be designed for high reliability with no moving parts including the processor, solid state hard drive, and available hot swap redundant power supply. The announcement controller shall be safety listed to UL Standard 60950.

H. The announcement controller shall include system configuration and management software. The announcement controller shall include internally hosted web page for configuration and monitoring the System Management Console.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following (or approved equivalent):

2.3 Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.IP Audio-Visual Endpoints

A. Wall-Mounted Speaker with display, microphone, and LED flasher

1. The device shall include factory assembled speaker, IP addressable PCB amplifier/control, integrated microphone, LCD/LED Display, and LED Multi-color Flasher.
2. The device shall have options to be flush mount or surface mounted with an enclosure.
3. The device shall incorporate an integrated microphone to allow full duplex talkback communication functionality based upon chosen software platform.
4. The speaker shall be an 8" Coaxial driver. The two reproducer sections shall be coupled through a built-in crossover network. Voice coil impedance shall be 8Ω.
5. The display shall be approximately 2” tall x 8” wide. It shall receive visual notifications from the management software, emergency alert software. It shall display the time when in standby mode from the management software or by NTP.
6. The LED flasher shall be able to produce RGB color spectrum. It shall have the capability of multi-speed flash rate and will be software controllable.
7. The amplifier/control board shall receive announcements and messages using dynamically routed data on a standard Ethernet Network. It shall include a Single-Channel Class D Topology amplifier with Primary and Secondary Outputs capable of producing 25-watts RMS when using an IEEE 802.3at compatible PoE+ switch or 24VDC local power supply and 12-watts RMS when used with an IEEE 802.3af compliant PoE switch. Interconnect shall be via female RJ-45 connector mounted to the PCB.
8. The amplifier/control board shall include (2) logic inputs, (1) relay output, (1) Auxiliary Unbalanced line level audio input and (1) Unbalanced line level audio output. The Auxiliary Line Level input shall include an auto mute function that is activated when a broadcast is sensed from the control application.
9. The amplifier/control board shall include a Graphical User Interface (GUI) for SIP configuration. The SIP implementation shall support standards G.711, G.722 and RTP protocols. The Graphical User Interface (GUI) shall configure and manage logic inputs, relay outputs, and Auxiliary audio input.

B. Dual-Sided Display with speaker and LED flasher

1. The device shall include factory assembled double sided LCD/LED displays, IP addressable PCB amplifier/control, small speaker(s), and LED Multi-color Flasher.
2. The device shall have options to be wall or ceiling mounted.
3. The speaker(s) shall be a 3” full range transducer. The voice coil impedance shall be 8Ω.
4. The display shall be approximately 2” tall x 8” wide. It shall receive visual notifications from the management software, emergency alert software. It shall display the time when in standby mode from the management software or by NTP.
5. The LED flasher shall be able to produce RGB color spectrum. It shall have the capability of multi-speed flash rate and will be software controllable.
6. The amplifier/control board shall receive announcements and messages using dynamically routed data on a standard Ethernet Network. It shall include a Single-Channel Class D Topology amplifier with Primary and Secondary Outputs capable of producing 25-watts RMS when using an IEEE 802.3at compatible PoE+ switch or 24VDC local power supply and 12-watts RMS when used with an IEEE 802.3af compliant PoE switch. Interconnect shall be via female RJ-45 connector mounted to the PCB.
7. The amplifier/control board shall include (2) logic inputs, (1) relay output, (1) Auxiliary Unbalanced line level audio input and (1) Unbalanced line level audio output. The Auxiliary Line Level input shall

include an auto mute function that is activated when a broadcast is sensed from the control application.

8. The amplifier/control board shall include a Graphical User Interface (GUI) for SIP configuration. The SIP implementation shall support standards G.711, G.722 and RTP protocols. The Graphical User Interface (GUI) shall configure and manage logic inputs, relay outputs, and Auxiliary audio input.
9. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equivalent.

2.4 IP-to-Analog Gateways

A. The IP-to-Analog network gateway shall have Unbalanced and Balanced line level outputs for connection to power amplifiers or 3rd party audio systems. The device shall incorporate an 8Ω, 70.7V amplified output to drive analog loudspeaker zones. It shall include two general purpose inputs and one relay output. The device shall incorporate a line level and microphone input.

B. The amplifier/control board shall receive announcements and messages using dynamically routed data on a standard Ethernet Network. It shall include a Single-Channel Class D Topology amplifier with Primary and Secondary Outputs capable of producing 25-watts RMS when using an IEEE 802.3at compatible PoE+ switch or 24VDC local power supply and 12-watts RMS when used with an IEEE 802.3af compliant PoE switch. Interconnect shall be via female RJ-45 connector mounted to the PCB.

C. The amplifier/control board shall include (2) logic inputs, (1) relay output, (1) Auxiliary Unbalanced line level audio input and (1) Unbalanced line level audio output. The Auxiliary Line Level input shall include an auto mute function that is activated when a broadcast is sensed from the control application.

D. The amplifier/control board shall include a Graphical User Interface (GUI) for SIP configuration. The SIP implementation shall support standards G.711, G.722 and RTP protocols. The Graphical User Interface (GUI) shall configure and manage logic inputs, relay outputs, and Auxiliary audio input.

E. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equivalent.

2.5 Analog Power Mixers/Amplifiers

A. The mixer/amplifier shall control and mix up to six signals. It shall output a minimum of 120 watts into 8ohm, 25V, or 70.7V.

B. The mixer/amplifier shall have thermal and short circuit protection.

C. The mixer/amplifier shall be rackmountable.

D. The mixer/amplifier shall include a stereo summing auxiliary input, unbalanced, -10dB, with dual RCA jacks. It shall also include a balanced bridge input/output allowing multiple amplifiers to be combined on one mixed bus.

E. The mixer/amplifier shall have a 400Hz 6dB per octave low cut filter.

F. The output shall be transformer isolated. It shall have less than 0.5% THD at rated output, and have a frequency response of 50Hz-20kHz (-3dB). The output regulation shall be less than 2dB, no load to full load.

G. The front panel shall include volume controls for all inputs along with master volume control, treble, and bass. It shall also include LEDs for power, system signal, and peak.

H. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equivalent.

2.6 Analog Speakers

A. Room Analog Speakers

1. Room analog speakers shall be used to supplement coverage in spaces too large for a single audio-visual endpoint.
2. Room analog speakers shall be wired in parallel to the loudspeaker of the IP audio-visual endpoints.
3. Room analog speakers shall have an 8-inch, 8ohm loudspeaker rated at 15watts RMS.
4. Room analog speakers shall have a sensitivity of 97dB and a frequency response of 45Hz-19kHz.

B. Corridor Analog Speakers

1. Corridor analog speakers shall be wired to the IP-to-analog gateway devices.
2. Corridor analog speakers shall have an 8-inch, 25V/70.7V loudspeaker with tap settings of 0.5, 1, 2, and 4 watts.
3. Corridor analog speakers shall have a sensitivity of 97dB and a frequency response of 45Hz-19kHz.

C. Horn Speakers

1. Horn speakers shall be used for large spaces and outdoor areas. They shall be wired to the IP-to-analog gateway devices.
2. Horn speakers shall include integral compression driver.
3. Horn speakers shall be made of structural aluminum and ABS plastic with an epoxy finish. They shall be weather resistant.
4. Horn speakers shall have a double re-rentrant path and exponentially flared bell.
5. Horn speakers shall have a sound dispersion angle of 70 degrees.
6. Horn speakers shall have a continuous power rating or 15 watts, with a frequency range of 400Hz-14kHz, and a sound pressure level of 106dB (1W/m).
7. Horn speakers shall have multiple power tap settings for 25V and 70.7V.
8. Mounting brackets shall allow vertical and horizontal adjustment. They shall include provisions for surface mounting, banding, or strapping.

D. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or approved equivalent.

2.7 Speaker Mounting Hardware

A. Baffles

1. Baffles shall be capable of supporting 8-inch loudspeakers via concealed mounting studs.
2. Baffles shall be made of 24-gauge cold rolled steel, with white textured epoxy finish.

B. Suspended Ceiling Enclosures

1. Suspended ceiling enclosures shall include pre-mount brackets, wingnuts, and support rails.
2. Support rails shall be adjustable, and capable of transferring the combined weight of the loudspeaker assembly to the ceiling grid.
3. Suspended ceiling enclosures shall be made of welded cold rolled steel, with black epoxy finish. They shall be undercoated to guard against acoustical and mechanical resonance.
4. Suspended ceiling enclosures shall be equipped with conduit knockouts.

2.8 Duress Buttons

A. Duress buttons shall

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following (or approved equivalent):

1. Safety Technology.

2.9 Cable and Cable Hardware

A. UTP cabling

B. Analog Audio Cable must meet the following criteria:

1. Speaker cable must be 18/2 stranded, with shield and drain wires.
2. Generic audio cable must be a minimum of 22/2 stranded wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for surface-mount raceway to verify actual locations of connections before equipment installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where Distributed Audio-Video Communications Systems will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 IDENTIFICATION

3.4 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of systems and equipment Installer. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacture's authorized replacement parts and supplies.

3.5 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for one year.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 275100

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Preamplifiers.
2. Power amplifiers.
3. Equipment cabinet.
4. Loudspeakers.
5. Battery backup power unit.
6. Conductors and cables.
7. Pathways.

B. Related Requirements:

1. Section 270000 “General Requirements for Communications”

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to operating console location.
    c. Training plan.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by manufacturers as indicated on the drawings.

B. Source Limitations: Obtain public address system from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from various inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

2.3 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with EIA/ECA-310-E.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.4 PREAMPLIFIERS

A. Preamplifier: Integral to power amplifier.

B. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.

C. Total Harmonic Distortion: Less than 1 percent.

D. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.

E. Input Jacks: Minimum of three. One matched for low-impedance microphone; one USB port; and the other matchable to DVD or CD player, or radio tuner signals without external adapters.

F. Minimum Noise Level: Minus 55 dB below rated output.

G. Controls: On-off, input levels, and master gain.

2.5 POWER AMPLIFIERS

A. Mounting: [**Console**] [**Rack**].

B. Output Power: 70-V balanced line, with enough overhead to supply a 10 percent allowance for future stations.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

D. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.

E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.6 EQUIPMENT CABINET

A. Comply with EIA/ECA-310-E.

B. House amplifiers and auxiliary equipment at each location.

C. Cabinet Housing:

1. Constructed of 0.0478-inch steel, minimum, with front- and rear-locking doors and standard EIA/ECA-310-E-compliant, 19-inch racks.
2. Arranged for floor or wall mounting as indicated.
3. Sized to house all equipment indicated.

D. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.

E. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

2.7 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet, unless noted otherwise.
4. Rated Output Level: as indicated on the drawings.
5. Minimum Dispersion Angle: 100 degrees unless noted otherwise.
6. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
7. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting.
8. Flush-Ceiling-Mounted Units:Metal ceiling grille with baked enamel finish. Color as indicated on the drawings.

B. Horn-Type Loudspeakers:

1. Type: Single-horn units, double-reentrant design, with minimum full-range power rating of 15 W, unless noted otherwise.
2. Matching Transformer: Full-power rated with four standard taps. Maximum insertion loss of 0.5 dB.
3. Frequency Response: Within plus or minus 3 dB from 250 to 12,000 Hz.
4. Dispersion Angle: 130 by 110 degrees, unless noted otherwise.
5. Mounting: Integral bracket.
6. Units in Damp, Wet, or Outdoor Locations: Listed and labeled for environment in which they are located.
7. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located. Provide any accessories required to maintain listing.

2.8 BATTERY BACKUP POWER UNIT

A. Unit shall be rack mounted, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.

B. Unit shall supply public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.

C. Battery shall be on float charge when not supplying system and able to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.

D. Unit shall automatically retransfer system to normal supply when normal power has been reestablished for three to five seconds continuously.

2.9 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multipair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
2. Plenum Cable: Listed and labeled for plenum installation.

2.10 PATHWAYS

A. Conduit and Boxes: Comply with Section 270528 "Pathways for Communications Systems."

1. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 270528 "Pathways for Communications Systems." for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

F. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

G. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

H. Connect wiring according to Section 271500 "Communications Horizontal Cabling."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of test performance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."

C. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

D. Public address system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within period of Service Warranty, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 275116

Downtown Greenville Technology Upgrades

City of Greenville

411 S. Lafayette St, Greenville, MI 48838

Project Number: GREN2202-0200

TECH DESIGN
251 N. ROSE STREET, SUITE 200, KALAMAZOO, MI 49007 269.203.2444 AETECH.DESIGN

City of Greenville
Downtown Greenville Technology Upgrades
411 S. Lafayette St, Greenville, MI 48838

Title Sheet

ISSUE / DATE
2023-01-11 BIDS

DRAWN BY
CDB

PROJECT NO.
GREN2202-0200

SHEET NO.
TG01

CABLING AND JACK LEGEND

PURPOSE	PREMISE CABLING				JACKS			
	COLOR	RATING	MANUFACTURER	MODEL	TR COLOR	WA COLOR	MANUFACTURER	MODEL
COPPER BACKBONE	BLUE	PLENUM	GENERAL CABLE	GENSPEED 6000	RED	RED	PANDUIT	CJ688TGRD
WIRELESS ACCESS POINTS					YELLOW	YELLOW		CJ688TGYL
PAGING					GREEN	GREEN		CJ688TGGR
SURVEILLANCE CAMERAS					VIOLET	VIOLET		CJ688TGVL
RESERVED					BLACK	BLACK		CJ688TGBL
POTS LINES					GRAY	GRAY		CJ688TGIG
GENERAL PURPOSE					WHITE	WHITE		CJ688TGWH

FIBER LEGEND

PURPOSE	TYPE	RATING	MANUFACTURER	MODEL
INDOOR/OUTDOOR	12 STRAND, SINGLE-MODE (OZ)	N/A	CORNING	ALTOS LITE LOOSE TUBE, GEL FREE, SINGLE-JACKET, SINGLE-ARMORED CABLE
PATCH CORD		N/A	UBIQUITI	UF-SM-PATCH-UPC-APC, UF-SM-PATCH-APC-APC

COPPER PATCH CORD LEGEND

PURPOSE	COLOR
GENERAL DATA	WHITE
WIRELESS ACCESS POINTS	YELLOW
SURVEILLANCE CAMERAS	VIOLET
PAGING	GREEN

RISER LEGEND

SYMBOL	DESCRIPTION
	ZONE OR AREA
	BY OTHERS OR EXISTING
	NEW
	OPTIONAL
	PLUG INTO 120V RECEPTACLE
	CONNECT TO GROUND
	WIFI CONNECTION
	GENERIC RF CONNECTION
	BLUETOOTH CONNCETION
	CELLULAR CONNECTION
8	8P8C (RJ45) NETWORK
8K	KEYED 8P8C (RJ45)
8S	SHIELDED 8P8C (RJ45)
CM	COMPONENT VIDEO
CS	COMPOSITE VIDEO
S	SVIDEO
V	HD15 (VGA) VIDEO
D	DVI VIDEO
H	HDMI VIDEO
LR	RED & WHITE RCA AUDIO
3S	3.5MM STEREO AUDIO
14	1/4" STEREO AUDIO
X	XLR MICROPHONE
F	COAX TYPE "F"
N	NEUTRIK NL4MP
U	USB

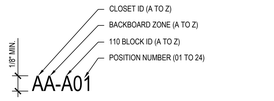
ABBREVIATIONS

ABBREVIATION	TERMINOLOGY
AC	ACCESS CONTROL
AFF	ABOVE FINISH FLOOR
ATS	AUTOMATIC TRANSFER SWITCH
AV OR A/V	AUDIO / VIDEO
BAS	BUILDING AUTOMATION SYSTEM
BB	BACKERBOARD
CIP	CAST IN PLACE
CLG	CEILING
CP	CONSOLIDATION POINT
EC	ELECTRICAL CONTRACTOR
EF	ENTRANCE FACILITY
EMT	ELECTRICAL METALLIC TUBING
EQ	EQUAL
EQUIV	EQUIVALENT
ER	EQUIPMENT ROOM
EXIST	EXISTING
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GRD	GROUND
HC	HORIZONTAL CROSS-CONNECT
IC	INTERMEDIATE CROSS-CONNECT
MC	MAIN CROSS-CONNECT
NIC	NOT IN CONTRACT
OC	ON CENTER
OSP	OUTSIDE PLANT
PBB	PRIMARY BONDING BUSBAR
PT	POKE-THROUGH
RBC	RACK BONDING CONDUCTOR
SBB	SECONDARY BONDING BUSBAR
SC	STRUCTURED CABLING
SCC	STRUCTURED CABLING CONTRACTOR
TBB	TELECOMMUNICATIONS BONDING BACKBONE
TE	TELECOMMUNICATIONS ENCLOSURE
TEBC	TELECOMMUNICATIONS EQUIPMENT BONDING CONDUCTOR
TO	TELECOMMUNICATIONS OUTLET
TR	TELECOMMUNICATIONS ROOM
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
UPS	UNINTERRUPTIBLE POWER SUPPLY
WA	WORK AREA

LIST OF DRAWINGS

GENERAL NOTES

1. FOR DROPS INSTALLED ABOVE ACCESSIBLE CEILING, PROVIDE MAINTENANCE LOOP AS INDICATED ON TECHNOLOGY SYMBOL LEGEND. CABLE SHALL BE NEATLY COILED IN AN "S" LOOP AND SECURED TO BUILDING STRUCTURE AT DROP LOCATION FOR EASY RELOCATION.
2. LOAD THE LATEST AVAILABLE FIRMWARE FOR ALL DEVICES WHEN THEY ARE SUPPLIED FOR THIS PROJECT.

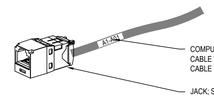


Numbering for 110-Block Term. Drops

NTS

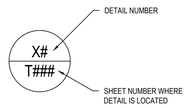
Numbering for Typical Data Drops

NTS



Cabling Label

6"=1'-0"



DETAIL CALLOUT

NTS

NOTES:
1. USED ON TECHNOLOGY FLOOR PLANS TO REFERENCE A DETAIL, ELEVATION, OR SYSTEM OF COMPONENTS ELEVATION ON ANOTHER SHEET.

ADDENDUM TAG

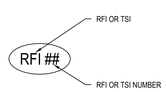
NTS

NOTES:
1. LOCATED NEXT TO A REVISION CLOUD FOR ANY REVISIONS AFTER BIDS HAVE BEEN RELEASED, BEFORE CONTRACT HAS BEEN AWARDED.

BULLETIN TAG

NTS

NOTES:
1. LOCATED NEXT TO A REVISION CLOUD FOR ANY REVISIONS AFTER CONTRACT HAS BEEN AWARDED.



RFI OR TSI TAG

NTS

NOTES:
1. RFI (REQUEST FOR INFORMATION) INDICATES A REVISION AND CORRESPONDING NOTE THAT DOES NOT AFFECT BUDGET THAT WAS NOT INITIATED BY TECHNOLOGY CONTRACTOR.
2. TSI (TECHNOLOGY INFORMATION) TAG INDICATES A REVISION AND CORRESPONDING NOTE THAT DOES NOT AFFECT BUDGET.

KEYED NOTE TAG

NTS

NOTES:
1. REFERENCE TO CORRESPONDING NOTES ON SAME SHEET THAT HAVE MORE INFORMATION RELATED TO SYMBOL.

REVISION CLOUD

NTS

NOTES:
1. DRAWN AROUND REVISION AREA RELATED TO ANY ADDENDUM OR BULLETIN.

NEW TECHNOLOGY

NTS

NOTES:
1. HEAVY SOLID LINE REPRESENTS NEW TECHNOLOGY. COMPLETE INSTALLATION OFTEN REQUIRES ROUGH-IN, CABLING, FACEPLATE AND/OR DEVICE. SEE DRAWINGS FOR MORE DETAIL.

DEMO TECHNOLOGY

NTS

NOTES:
1. HEAVY DASHED LINE REPRESENTS EXISTING TECHNOLOGY TO BE REMOVED. COULD REQUIRE DEMOLITION OF ROUGH-IN, CABLING, FACEPLATE AND/OR DEVICE. DEVICE MAY NEED TO BE SALVAGED FOR REINSTALLATION OR TURNED OVER TO OWNER. SEE DRAWINGS FOR MORE DETAIL.

EXISTING TECHNOLOGY

NTS

NOTES:
1. THIN SOLID LINE REPRESENTS EXISTING TECHNOLOGY TO REMAIN. NO WORK REQUIRED AT SPECIFIC LOCATION, BUT COULD REQUIRE EXISTING CABLING AND/OR DEVICES TO BE MAINTAINED DURING CONSTRUCTION TO SUPPORT SPECIFIC DEVICE. SEE DRAWINGS FOR MORE DETAIL.

TECH DESIGN
251 N. ROSE STREET, SUITE 200, KALAMAZOO, MI 49007 269.203.2444 AETECHDESIGN

City of Greenville
Downtown Greenville Technology Upgrades
411 S. Lafayette St, Greenville, MI 48838

Technology General Information

ISSUE / DATE
2023-01-11 BIDS

DRAWN BY
CDB

PROJECT NO.
GREN2202-0200

SHEET NO.
TG02

Technology Site Plan - Composite
1" = 80'-0"

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Downtown Greenville Technology Upgrades
411 S. Lafayette St, Greenville, MI 48838

Technology Site Plan - Composite

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SHEET NO.
TS01

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Technology Site Plan - Surveillance
1" = 80'-0"

City of Greenville

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Technology Site Plan - Surveillance

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N

1" = 80'-0"

Technology Site Plan - Paging

TS03

SHEET NO.

PROJECT NO.
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Technology Site Plan - Paging

TECH DESIGN
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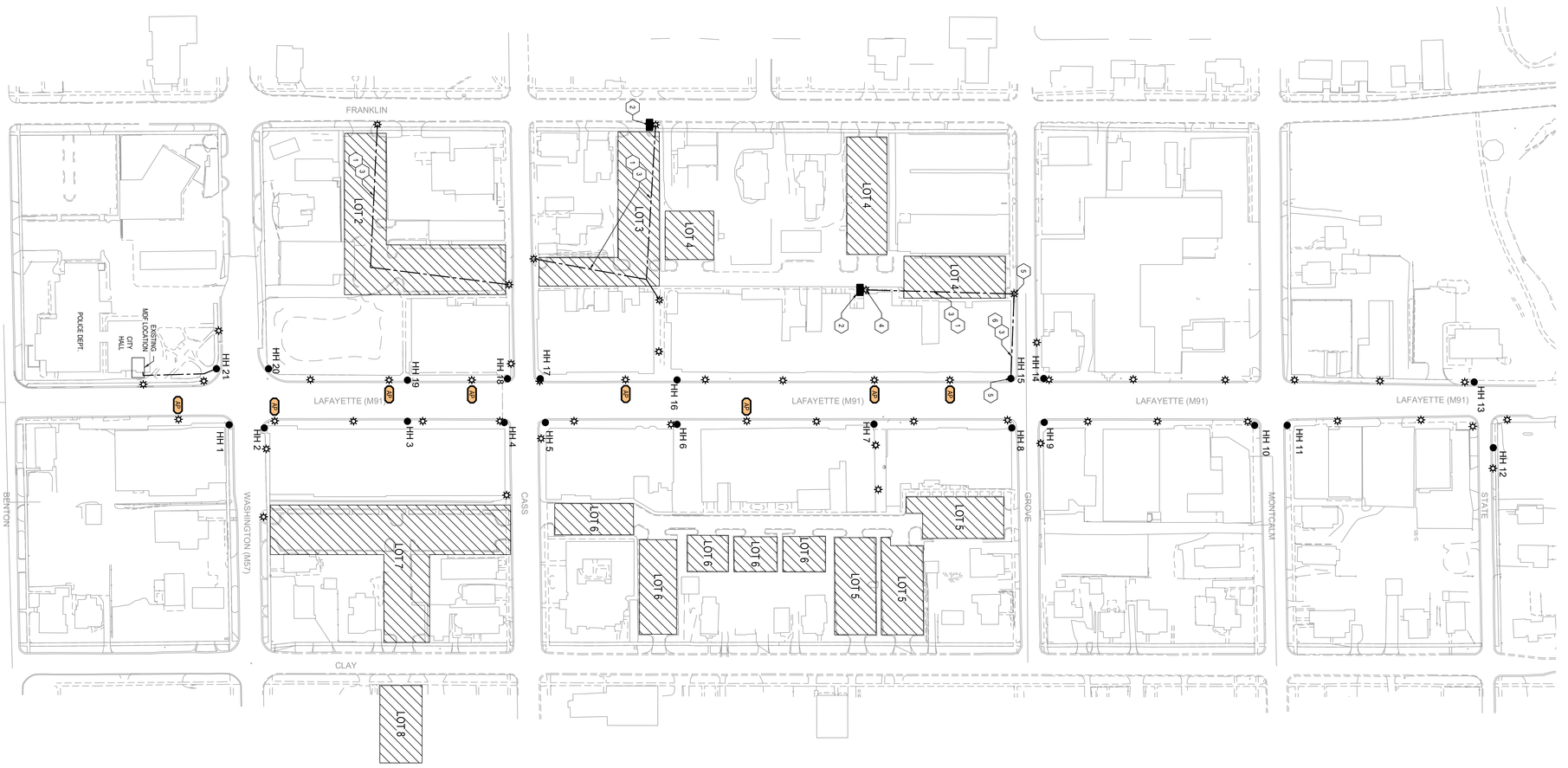

Technology Site Plan - Network
1" = 80'-0"

City of Greenville

Downtown Greenville Technology Upgrades

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Technology Site Plan - Network

ISSUE / DATE	2023-01-11 BIDS

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PROJECT NO.	GREN2202-0200
SHEET NO.	TS04

TECH DESIGN
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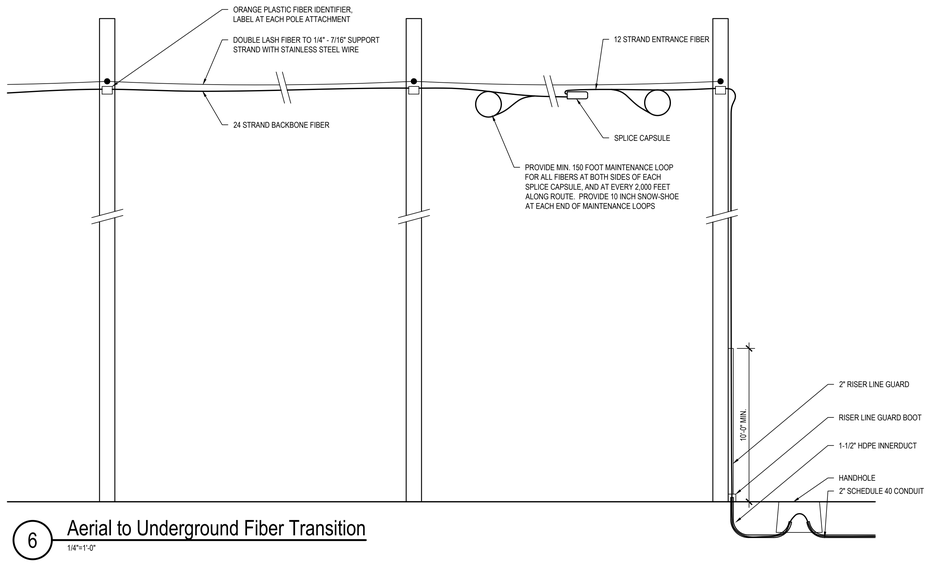
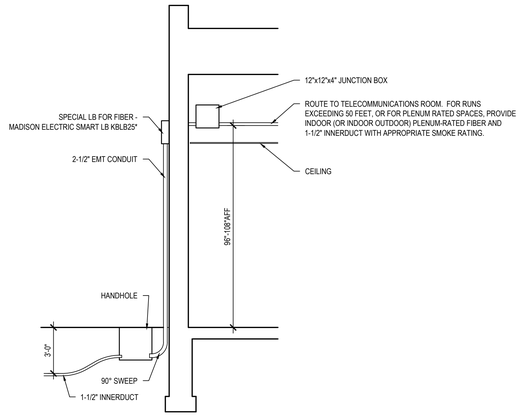
FIBER GENERAL NOTES

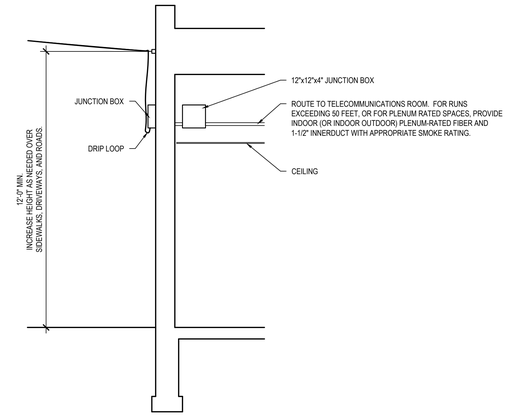
1. INSTALL ALL HANDHOLES AND DUCTS WITHIN PUBLIC ROAD RIGHT-OF-WAY OR ON OWNER'S PRIVATE PROPERTY.
2. ALL DUCTS RUNNING BETWEEN HANDHOLES ARE TO BE CONTINUOUS WITHOUT SPLICES OR COUPLERS.
3. ALL HANDHOLES TO HAVE POLYMER CONCRETE LIDS INSCRIBED WITH THE WORD "COMMUNICATIONS"



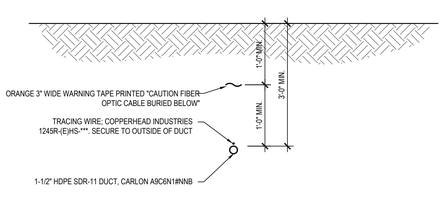
6 Aerial to Underground Fiber Transition
1/4"=1'-0"



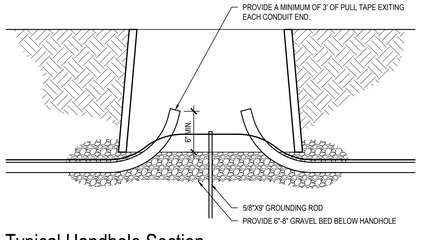
5 Typical Underground Fiber Entrance
NTS



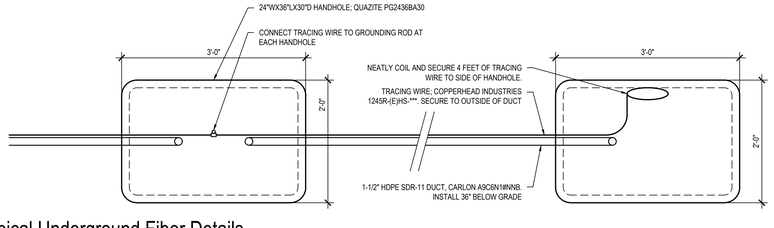
4 Typical Aerial Fiber Entrance
NTS



3 Typical Fiber Installation Detail
1"=1'-0"



2 Typical Handhole Section
1"=1'-0"



1 Typical Underground Fiber Details
1"=1'-0"

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Technology Site Plan Details

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SHEET NO.
TS05

DATA LEGEND

SYMBOL EXISTING	SYMBOL DEMO	SYMBOL NEW	DESCRIPTION	HEIGHT	DATA DROPS	NEW WORK ROUGH-IN	NEW WORK FACEPLATE	SURFACE MOUNT ROUGH-IN	SURFACE MOUNT FACEPLATE	NOTES ELECTRICAL	NOTES LOW VOLTAGE
0	0	0	DATA DROP - BLANK	18"AFF	0	1/T302	SEE NOTES	6/T302	SEE NOTES		1
#	#	#	DATA DROP - (# INDICATED)	18"AFF	#	1/T302	SEE NOTES	6/T302	SEE NOTES		2
FB #	FB #	FB #	DATA DROP - FLOOR BOX	FLOOR	#	SEE ELEC. NOTES	SEE NOTES	N/A	SEE NOTES	7	2
CH #	CH #	CH #	DATA DROP - COUNTERHEIGHT	SEE ELEC. NOTES	#	1/T302	SEE NOTES	6/T302	SEE NOTES	8	2
FR #	FR #	FR #	DATA DROP - FURNITURE	18"AFF	#	5/T302	11/T302	5/T302	11/T302	9	6
CW #	CW #	CW #	DATA DROP - CASEWORK	18"AFF	#	3/T302	SEE NOTES	7/T302	SEE NOTES	10	2
AP	AP	AP	WIRELESS ACCESS POINT	SEE NOTES	1	N/A	12/T302	N/A	12/T302		3,13
AP	AP	AP	WIRELESS ACCESS POINT - WALL MOUNT	144"AFF	1	1/T302	8/T302	6/T302	8/T302		3
P	P	P	ANALOG PHONE DROP	N/A	1	N/A	N/A	N/A	N/A	11	4
W	W	W	WALL PHONE	54"AFF	1	1/T302	13/T302	6/T302	13/T302		5
F	F	F	FACILITIES DROP	SEE ELEC. NOTES	1	N/A	12/T302	N/A	12/T302	12	

DATA LEGEND NOTES

1. PROVIDE BLANK FACEPLATE.
2. 8/T302, 9/T302, OR 10/T302 DEPENDING ON THE NUMBER OF DROPS.
3. PROVIDE 20 FEET OF MAINTENANCE LOOP FOR CABLE.
4. TERMINATE ON 110 BLOCK IN TELECOMMUNICATIONS ROOM (TR).
5. TERMINATE ON PATCH PANEL IN TECH CLOSET.
6. ROUTE CABLES THROUGH FURNITURE TO FURNITURE FACEPLATE.
7. 3/T302 OR 4/T302 AS NEEDED.
8. MATCH ELEC. ROUGH-IN HEIGHT, TYPICALLY 8" ABOVE COUNTERTOP.
9. FACTORY CUT ROUGH-IN PROVIDED IN MODULAR FURNITURE.
10. PROVIDE ROUGH-IN IN FIXED CASEWORK.
11. COORDINATE LOCATION W/ EQUIPMENT SERVED.
12. COORDINATE FINAL LOCATION W/ BUILDING AUTOMATION SYSTEM CONTRACTOR.
13. POLE MOUNTED ON STREET LIGHT POLE. SEE 2/T303 FOR DETAILS.

INFORMATION TAG
DROP TYPE OR QUANTITY

X #

DATA DROP SYMBOL

DATA COUNT LEGEND

SYMBOL	DESCRIPTION	DATA DROPS
CM1	CAMERA - OUTDOOR	1
CM2	CAMERA - OUTDOOR PTZ	1
CM3	CAMERA - OUTDOOR MULTIVIEW	1
SS1	SPEAKER - POLE MOUNTED	1

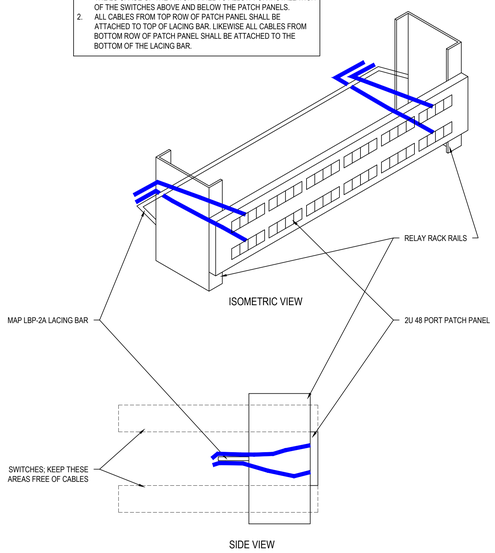
CABLING SUPPORT LEGEND

SYMBOL	DESCRIPTION	NOTES ELECTRICAL	NOTES LOW VOLTAGE
	1-1/2" EMT SLEEVE W/ BUSHINGS		
	1-1/2" EMT SLEEVE W/ BUSHINGS; SEAL ENDS W/ FIRE-PROOF PUTTY		
	1-1/2" EMT SLEEVE W/ BUSHINGS (UP)		
	1-1/2" EMT SLEEVE W/ BUSHINGS (DOWN)		
	4" EMT SLEEVE W/ BUSHINGS		
	STI EZ-PATH SERIES 44 OR APPROVED EQUIVALENT		
	4" EMT SLEEVE W/ BUSHINGS (UP)		
	4" EMT SLEEVE W/ BUSHINGS (DOWN)		

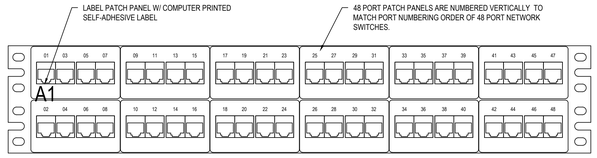
CABLING SUPPORT LGND NOTES

1. NONE

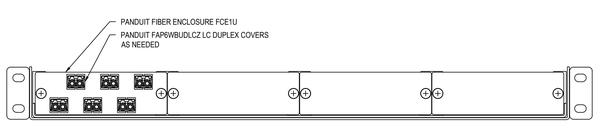
NOTES:
1. USE LACING BAR AT REAR OF RACK TO KEEP ALL CABLES WITHIN THE 2U SPACE OF THE PATCH PANEL TO ALLOW FOR INSTALLATION OF THE SWITCHES ABOVE AND BELOW THE PATCH PANELS.
2. ALL CABLES FROM TOP ROW OF PATCH PANEL SHALL BE ATTACHED TO TOP OF LACING BAR. LIKEWISE ALL CABLES FROM BOTTOM ROW OF PATCH PANEL SHALL BE ATTACHED TO THE BOTTOM OF THE LACING BAR.



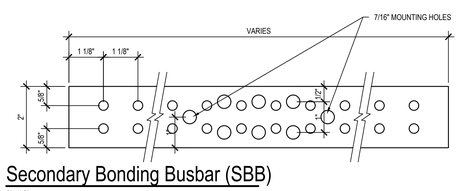
Lacing Bar Detail
NTS



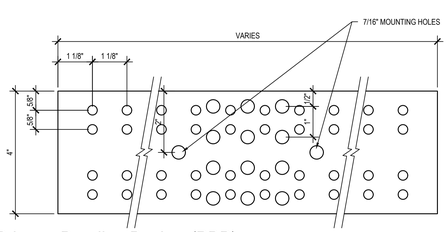
Typical Numbering for 48-Port Patch Panel
6"=1'-0"



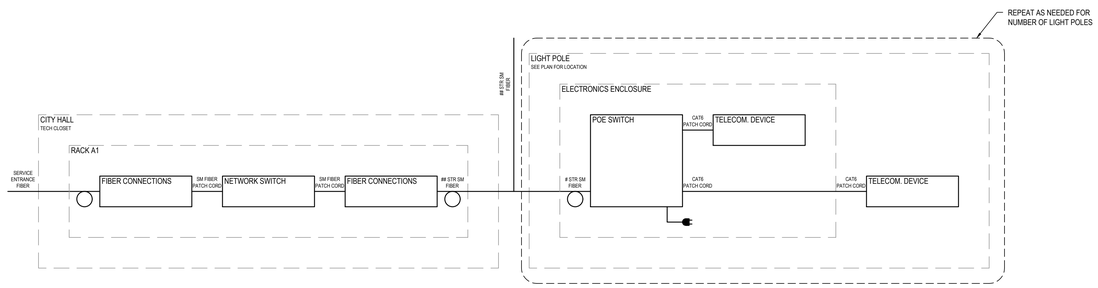
Fiber Panel Detail (TYP.)
6"=1'-0"



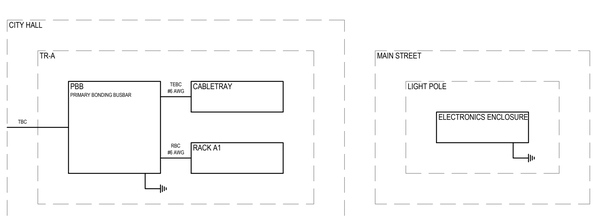
Secondary Bonding Busbar (SBB)
6"=1'-0"



Primary Bonding Busbar (PBB)
6"=1'-0"



Cabling Distribution Riser (TYP.)
NTS



Telecommunications Grounding Riser
NTS

STRUCTURED CABLING NOTES

1. FOR ALL ALPHABETIC IDENTIFIERS THE LETTERS "O" AND "I" ARE NOT USED, TO PREVENT POSSIBLE CONFUSION WITH THE NUMBERS ZERO AND ONE.
2. ALL ANALOG PHONE DROPS ARE TO BE TERMINATED IN TECH CLOSETS ON 110 PUNCH-DOWN BLOCKS MOUNTED ON BACKBOARD.

CABLING DISTRIBUTION NOTES

1. PROVIDE 10 FEET OF MAINTENANCE LOOP AT TECHNOLOGY ROOM AND 1 FOOT OF MAINTENANCE LOOP AT WORK AREA FOR ALL CABLING UNLESS NOTED OTHERWISE.
2. FOR EACH RUN OF BACKBONE FIBER BETWEEN TECHNOLOGY ROOMS, TERMINATE 2 STRANDS. TEST ALL STRANDS.
3. SEE PATCH CORD LEGEND AND CABLING AND JACK LEGEND ON TG02 FOR MORE INFORMATION REGARDING APPROPRIATE COLORS REQUIRED.
4. CABLING THAT ENTERS AND EXITS THE POLE-MOUNTED ENCLOSURE SHALL BE ENCLOSED IN LIQUIDTIGHT ELECTRIC TUBING AND SEALED PROPERLY AT EACH END.

GROUNDING NOTES

1. ELECTRONICS LOCATED IN ENCLOSURE ON LIGHT POLES SHALL BE GROUNDED TO THE ENCLOSURE, AND ENCLOSURE GROUNDED TO THE POLE.
2. GROUNDING BUSBARS IN EVERY TECH CLOSET TO BE CONNECTED TO AVAILABLE BUILDING STEEL AND ELECTRICAL PANELS (TYP.).

TECH DESIGN
251 N. ROSE STREET, SUITE 200, KALAMAZOO, MI 49007 269.203.2444 AETECH.DESIGN

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Structured Cabling General Information

ISSUE / DATE
2023-01-11 BIDS

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PROJECT NO.
GREN2202-0200

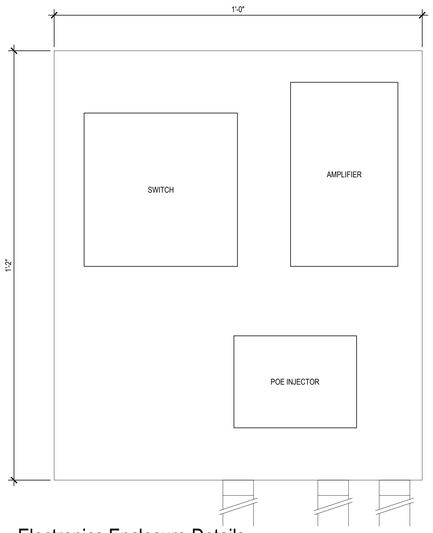
SHEET NO.
T301

LIGHT POLE GENERAL NOTES

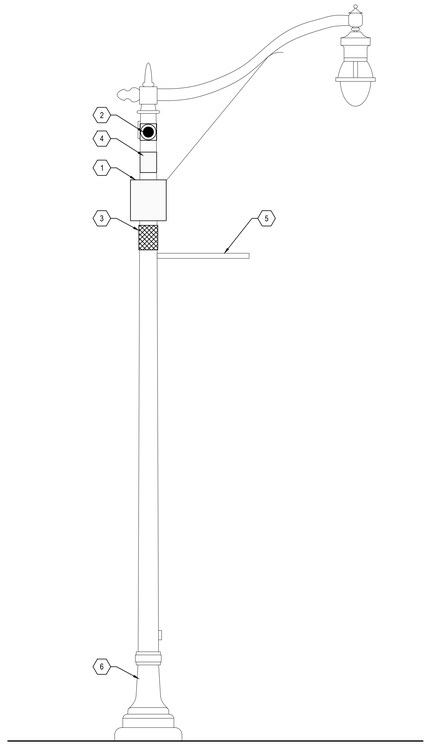
1. MOUNT EQUIPMENT AS TO ALLOW PROPER EQUIPMENT CLEARANCES AND AVOID EXISTING LIGHT POLE FEATURES.
2. CABLING THAT ENTERS AND EXITS THE POLE-MOUNTED ENCLOSURE SHALL BE ENCLOSED IN LIQUIDTIGHT ELECTRIC TUBING AND SEALED PROPERLY AT EACH END.
3. ELECTRONICS RESIDING IN ENCLOSURE SHALL BE MOUNTED ON A BACK-PLATE AND PROPERLY SPACED FOR HEAT DISSIPATION AND CABLING PRIOR TO FINAL INSTALLATION IN ENCLOSURE.
4. ACTUAL EQUIPMENT INSTALLED IN EACH ENCLOSURE WILL VARY BY POLE. REFER TO PLANS FOR POLE SPECIFIC EQUIPMENT.

LIGHT POLE KEYED NOTES

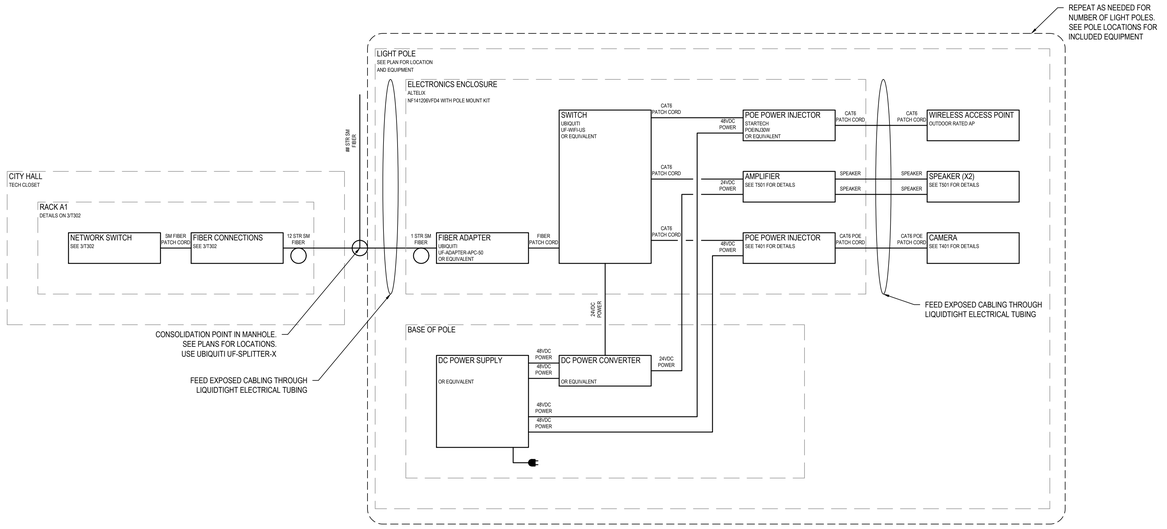
1. EXTERIOR ELECTRONICS ENCLOSURE. SEE DETAILS 3/T303. COORDINATE FINAL COLOR WITH OWNER.
2. SURVEILLANCE CAMERA (TYP.). REFER TO PLANS FOR SPECIFIC MODEL LOCATION AND VIEWS. MOUNTING HEIGHT AND STYLE MAY VARY. SEE DETAILS ON T401.
3. LOUDSPEAKER. SEE DETAILS ON T501.
4. WIRELESS ACCESS POINT.
5. EXISTING POLE BANNER ARM. INSTALL ALL EQUIPMENT ABOVE THIS ARM ON APPLICABLE POLES.
6. DC POWER SUPPLY LOCATED IN BASE OF LIGHT POLE.



3 Electronics Enclosure Details
NTS



2 Light Pole Elevation (TYP.)
NTS



1 Electronics Enclosure (TYP.) Detail Riser
NTS

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Downtown Greenville Technology Upgrades
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Structured Cabling Light Pole Details

ISSUE / DATE
2023-01-11 BIDS

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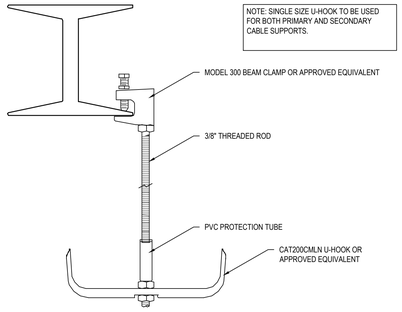
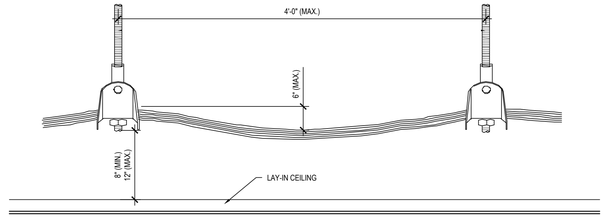
PROJECT NO.
GREN2202-0200

SHEET NO.
T303



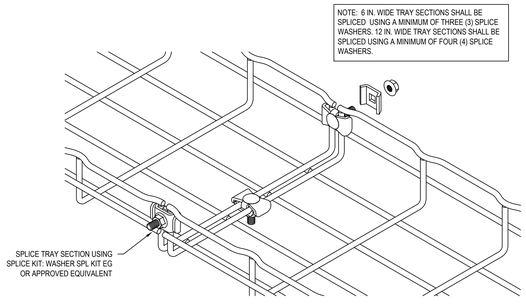
Cable Support Assembly Detail (J-Hooks)

NTS



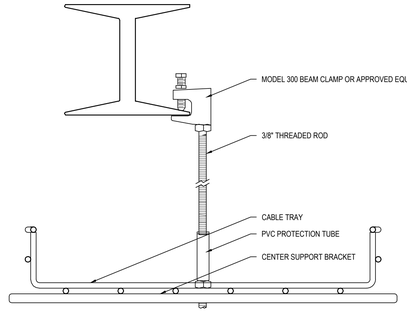
Cable Support Installation Detail (J-Hooks)

NTS



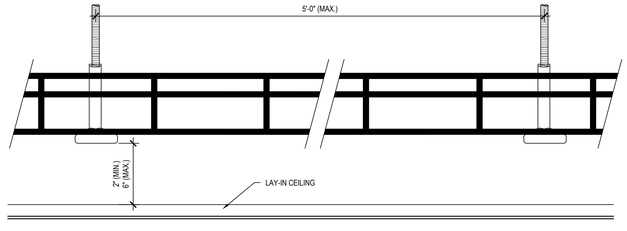
Cable Support Coupling Detail (Cabletray)

NTS



Cable Support Assembly Detail (Cabletray)

NTS



Cable Support Installation Detail (Cabletray)

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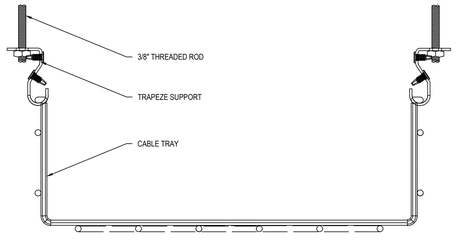
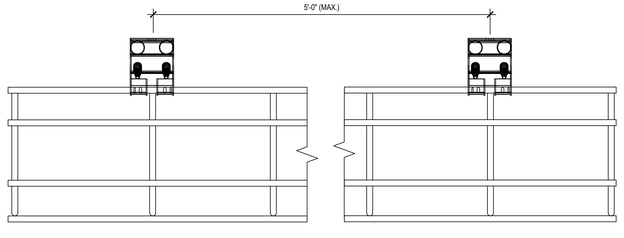


Cable Support Assembly Detail (Cabletray)

NTS



Cable Support Installation Detail (Cabletray)

NTS

TECH DESIGN
251 N. ROSE STREET, SUITE 200, KALAMAZOO, MI 49007 269.203.2444 AETECH.DESIGN

City of Greenville
Downtown Greenville Technology Upgrades
411 S. Lafayette St, Greenville, MI 48838

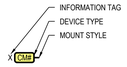
Structured Cabling Support Information

ISSUE / DATE
2023-01-11 BIDS

DRAWN BY
CDB
PROJECT NO.
GREN2202-0200
SHEET NO.
T304

CAMERA LEGEND

SYMBOL	DESCRIPTION	HEIGHT	DATA DROPS	NEW WORK		SURFACE MOUNT		NOTES	
				ROUGH-IN	FACEPLATE	ROUGH-IN	FACEPLATE	ELECTRICAL	LOW VOLTAGE
CM1	DOME CAMERA	SEE NOTES	SEE T301	N/A	1/T401	N/A	1/T401		1
CM2	MULTIVIEW CAMERA	SEE NOTES	SEE T301	N/A	1/T401	N/A	1/T401		1
CM3	BULLET CAMERA	SEE NOTES	SEE T301	N/A	1/T401	N/A	1/T401		1



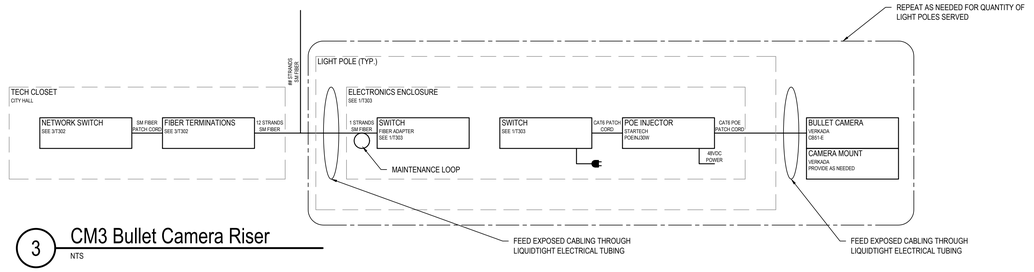
CAMERA SYMBOL

CAMERA LEGEND NOTES

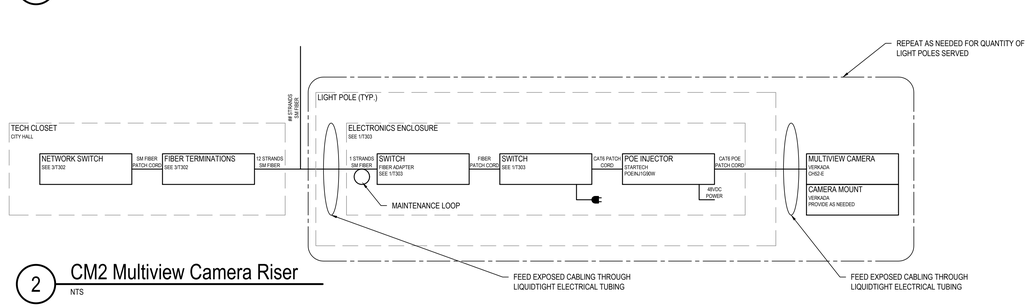
1. CAMERA MOUNTED ON LIGHT POLE UNLESS SHOWN OTHERWISE ON PLANS. REFER TO 2/T303 FOR POLE MOUNT APPLICATIONS.

CAMERA NOTES

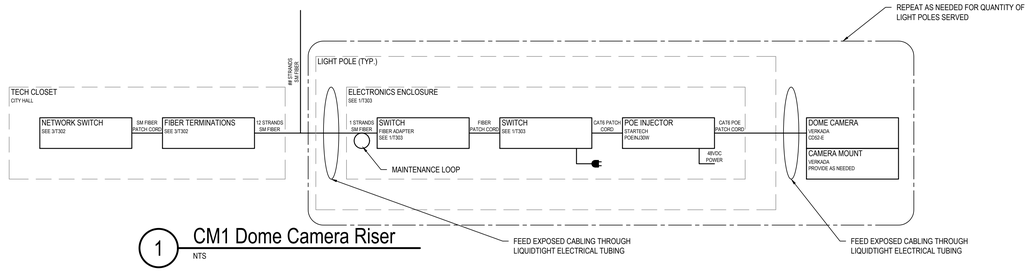
1. INSTALL AND CONFIGURE SERVER LICENSING AS NEEDED. PROVIDE ONE CAMERA LICENSE AND ONE SUPPORT LICENSE FOR EACH CAMERA INSTALLED. CONFIGURE SOFTWARE PER SPECIFICATION TO SUPPORT ALL CAMERAS.
2. RELOCATE CAMERA DATA DROP AS REQUIRED FOR OPTIMAL CAMERA POSITION. NEATLY COIL AND SECURE ANY REMAINING MAINTENANCE LOOP TO BUILDING STRUCTURE.
3. SECURE EXTERIOR CAMERAS TO BUILDING AT MINIMUM OF 144"AFF, UNLESS NOTED OTHERWISE.
4. CAMERA CONTRACTOR IS RESPONSIBLE FOR DRILLING ANY HOLES THAT ARE REQUIRED TO PROVIDE PATHWAY FOR CAMERA PATCH CORDS. SEAL ALL PENETRATIONS APPROPRIATELY (REMOVABLE WATERPROOF CAULK FOR EXTERIOR WALLS, AND FIRE-PROOF PUTTY FOR FIRE-RATED WALLS).
5. CAMERA CONTRACTOR TO PROVIDE MOUNTING HARDWARE AS NEEDED BASED ON CAMERA TYPE AND MOUNTING LOCATION.
6. IMPORT BUILDING FLOOR PLANS AND PLACE CAMERA ICONS TO ALLOW VIEWING SELECTION OF A GIVEN CAMERA FROM THE SOFTWARE INTERFACE.
7. ASSIST THE OWNER IN LOADING AND USAGE OF VIEWING SOFTWARE ON UP TO FIVE (5) COMPUTERS AND PROVIDE ABILITY TO VIEW CAMERAS FROM A MOBILE DEVICE TO THE EXTENT POSSIBLE WITH THE SYSTEM.
8. CABLING THAT ENTERS AND EXITS THE POLE-MOUNTED ENCLOSURE SHALL BE ENCLOSED IN LIQUIDTIGHT ELECTRIC TUBING AND SEALED PROPERLY AT EACH END.



3 CM3 Bullet Camera Riser
NTS



2 CM2 Multiview Camera Riser
NTS



1 CM1 Dome Camera Riser
NTS

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Security Systems General Information

ISSUE / DATE
2023-01-11 BIDS

DRAWN BY
CDB

PROJECT NO.
GREN2202-0200

SHEET NO.
T401

PAGING LEGEND

SYMBOL	DESCRIPTION	HEIGHT	DATA DROPS	NEW WORK		SURFACE MOUNT		NOTES	
				ROUGH-IN	FACEPLATE	ROUGH-IN	FACEPLATE	ELECTRICAL	LOW VOLTAGE
ST	SPEAKER	SEE NOTES	SEE T301	SEE ELEC. NOTES	N/A	N/A	N/A		1

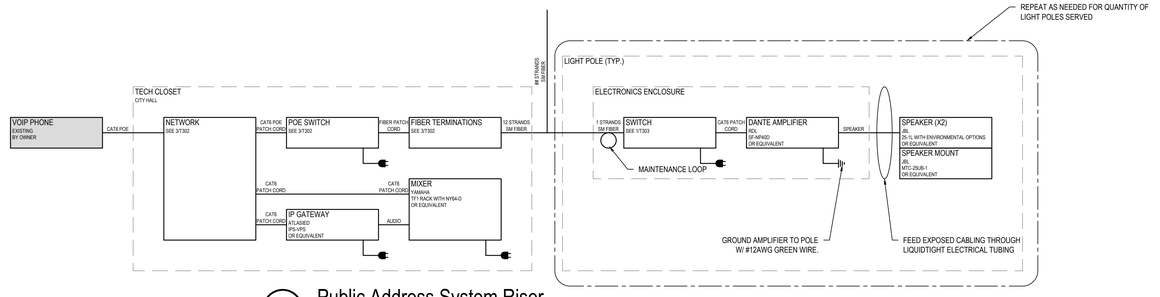
PAGING SYMBOL

PAGING LEGEND NOTES

1. POLE MOUNTED. SEE DETAILS ON 2/T303.

DISTRIBUTED SYSTEMS NOTES

1. CABLING THAT ENTERS AND EXITS THE POLE-MOUNTED ENCLOSURE SHALL BE ENCLOSED IN LIQUIDTIGHT ELECTRIC TUBING AND SEALED PROPERLY AT EACH END.



1 Public Address System Riser
NTS

TECH DESIGN
251 N. ROSE STREET, SUITE 200, KALAMAZOO, MI 49007 269.203.2444 AETECH.DESIGN

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Downtown Greenville Technology Upgrades
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Distributed Systems General Information

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DRAWN BY
CDB

PROJECT NO.
GREN2202-0200

SHEET NO.
T501