TOMBALL INDEPENDENT SCHOOL DISTRICT

RFQ #947-23 – TWC-HS

ISSUED: November 6, 2023
REQUEST FOR COMPETITIVE SEALED PROPOSALS FOR
THE A NEW 3,000 STUDENT HIGH SCHOOL CAMPUS

Addendum No. 02

November 17, 2023

Questions and Clarifications to the RFP Document:

1. *Question:* Can you provide the Insurance and Bond requirements referenced?
   Response: See attached Exhibits for Insurance and Bond Requirements.
2. *Question:* Would it possible to get a list of the key sub-contractors currently working at the Juergen Rd site on the Elementary and Intermediate Schools.
   Response: See Below. Use of these sub-contractors does not affect or change any bidder's position on bid day.

Underground Utilities	Franco
Concrete	Pena's Concrete
Masonry	City Masonry
Steel Erection	Empire
Non-Electrical Cabling	Accutek
Mechanical	K&S Contracting
	Envirotech
Electrical	Elite
Plumbing	Jarrar & Company
Millwork	Jericho Woodworks
Site/Earthwork/Detention/Underground	Lonnie Lischka Company
	Franco
	Unitas Construction
Water Treatment Plant	B-5 Construction

3. *Question:* Is the BIM model available for us to use in our bidding process?
   Response: Yes. Please contact the Architect. You will have to utilize their form which is already included in the specifications.
4. Administrative Comment for Clarity. Please delete all the Harris County Code Review sheets, (G2.00.1 through G2.00.7) from the bid documents. That information is not considered a part of the bidding process.

Questions and Clarifications to the Drawings:

1. *Question:* None at this time.
   Response:

Questions and Clarifications to the Specifications:

1. *Question:* General questions regarding the Specifications.
   Response: See attached Addendum information issued by the Architect.

End of Addendum

EXHIBIT A

Insurance and Bond Requirements

Part 1: CONTRACTOR'S LIABILITY INSURANCE

The Contractor shall carry and maintain in force the insurance described below. Prior to execution of the Contract, the Contractor shall procure insurance coverage in the types and amounts as follows:

1. Workmen's Compensation	All liability arising out of Contractor's employment of workers and anyone for whom Contractor shall be liable for Worker's Compensation claims. Worker's Compensation is required and no "alternative" form of insurance shall be permitted. Waiver of Subrogation in favor of Owner and Program Manager required.
2. Employer's Liability	$1,000,000.00
3. Commercial General Liability	
a. Each Occurrence	$1,000,000.00
b. General Aggregate	$2,000,000.00 (A Designated Construction Project General Aggregate Limit shall be provided)
c. Personal & Advertising Injury	$1,000,000.00 (Each Person)
d. Products & Completed Operations	$1,000,000.00 (for one (1) year commencing with issuance of Final Certificate of Payment)
4. Property Damage	
a. Each Occurrence	$1,000,000.00
b. Aggregate	$2,000,000.00
c. Independent Contractors	$1,000,000.00 (Each Occurrence), $2,000,000.00 (Aggregate)
5. Commercial Automobile Liability	
a. Bodily Injury/Property Damage	$1,000,000.00 (Combined single limit)
6. Umbrella or Excess Liability	
a. Each Occurrence and Aggregate	(a) One times Contract amount for all Contracts with the following minimum and maximum: (i) $1,000,000.00 minimum limit (ii) $25,000,000.00 maximum limit (b) The Umbrella shall provide coverage over the workmen's compensation, comprehensive general liability, and comprehensive automobile liability.
7. All Risk Builder's Risk	All Risk Builder's Risk against the perils of fire, lightening, wind storm, hurricane, hail, explosion, riot, civil commotion, smoke, aircraft, land vehicles, vandalism, malicious mischief, and all other perils in the amount one hundred percent (100%) of the value of the improvements including transit and materials stored off site. Additionally, this coverage shall provide protection to the full replacement value for boiler and machinery

	equipment up to installation, during testing, and until acceptance by Owner.

1. The required insurance must be written by a company licensed to do business in Texas at the time the policy is issued. In addition, the company must be acceptable to the Owner. The Owner's Representative will contact the State Board of Insurance to confirm that the issuing companies are admitted and authorized to issue such policies in the State of Texas.
2. The General Liability and Automobile so issued in the name of Contractor shall also name the Owner and Program Manager as additional insured. The coverage afforded to the additional insured under the policy or policies shall be primary insurance. It is the intent of the parties to this Agreement that the General Liability coverage required herein shall be primary to and shall seek no contribution from all insurance available to Owner, with Owner's insurance being excess, secondary and non-contributing. The Commercial General Liability coverage provided by Contractor shall be endorsed to provide such primary and non-contributing liability. If the additional insured has other insurance which is applicable to the loss, such other insurance shall be on an excess or contingent basis.
3. If the insurance is written with stipulated amounts deductible under the terms of the policy, the Contractor shall pay the difference attributable to deductions in any payment made by the insurance carrier on claims paid by this insurance to the extent Contractor the subject loss is due to the fault of Contractor. If the Owner is damaged by the failure of the Contractor to maintain such insurance and to so notify the Owner then the Contractor shall bear all reasonable costs properly attributable thereto.
4. The insurance required by this Exhibit A shall be written for not less than limits of liability specified in the Contract Documents or required by law, whichever coverage is greater. Coverages, whether written on an occurrence or claims-made basis, shall be maintained without interruption from the date of commencement of the Work until the date of final payment and termination of any coverage required to be maintained after final payment, and, with respect to the Contractor's completed operations coverage, until the expiration of the period for correction of Work or for such other period for maintenance of completed operations coverage as specified in the Contract Documents. Nothing contained herein shall limit or waive Contractor's legal or contractual responsibilities to Owner or others.
5. Contractor shall have its insurance carrier(s) furnish to Owner insurance certificates in form satisfactory to Owner specifying the types and amounts of coverage in effect, the expiration dates of each policy, and a statement that no insurance will be canceled or materially changed while the Work is in progress without thirty (30) calendar day's prior written notice to Owner. Contractor shall permit Owner to examine the insurance policies, or at Owner's option, Contractor shall furnish Owner with copies, certified by the carrier(s), of insurance policies required in Exhibit A. If Contractor neglects or refuses to provide any insurance required herein, or if any insurance is canceled, Owner may, but shall not be obligated to, procure such insurance and the provisions of Section 7 hereof shall apply.
6. Contractor and its Subcontractors shall not commence the shipment of equipment or materials or commence the Work at the site until all of the insurance coverage required of Contractor and its Subcontractors are in force and the necessary certificates and statements pursuant to Section 5 hereof have been received by Owner and the Architect or Owner has issued a written notice to proceed.
7. As an alternative and at Owner's option and expense, Owner may elect to furnish or to arrange for any part or all of the insurance required by Exhibit A hereof. If Owner so elects, it shall notify, in writing, Contractor and issue a Change Order therefor, but no adjustment to the scheduled completion date or the Contract Sum shall be allowed.
8. A copy of a certificate of insurance, a certificate of authority to self-insure issued by the Texas Workers' Compensation Commission, or a coverage agreement (DWC-81, DWC-82, DWC-83, or

DWC-84), showing statutory Workers' Compensation insurance coverage for the person's or entity's employees providing services on a Project is required for the duration of the Project.

a. Duration of the Project includes the time from the beginning of the Work on the Project until the Contractor's/person's Work on the Project has been completed and accepted by the Owner.
b. Persons providing services on the Project ("Subcontractor" in Texas Labor Code 406.096) include all persons or entities performing all or part of the services the Contractor has undertaken to perform on the Project, regardless of whether that person contracted directly with the Contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, contractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity that furnishes persons to provide services on the Project.
c. Services include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a Project. Services do not include activities unrelated to the Project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.
d. The Contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code Section 401.011(44) for all employees of the Contractor providing services on the Project for the duration of the Project.
e. The Contractor must provide a certificate of coverage to the Owner prior to being awarded the contract.
f. If the coverage period shown on the Contractor's current certificate of coverage ends during the duration of the Project, the Contractor must, prior to the end of the coverage period, file a new certificate of coverage with the Owner showing that coverage has been extended.
g. The Contractor shall obtain from each person providing services on a Project, and provide to the Owner:
    i. A certificate of coverage, prior to that person beginning Work on the Project, so the Owner will have on file certificates of coverage showing coverage for all persons providing services on the Project; and
    ii. No later than seven (7) days after receipt by the Contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the Project.
h. The Contractor shall retain all required certificates of coverage for the duration of the Project and for one (1) year thereafter.
i. The Contractor shall notify the Owner in writing by certified mail or personal delivery, within ten (10) days after the Contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the Project.
j. The Contractor shall post on each Project site a notice, in the text, form, and manner prescribed by the Texas Workers' Compensation Commission, informing all persons providing services on the Project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.
k. The Contractor shall contractually require each person with whom it contracts to provide services on a Project, to:
    i. Provide coverage, based on proper reporting of classification codes and payroll

amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code 401.011(44) for all of its employees providing services on the Project for the duration of the Project;

ii. Provide to the Contractor, prior to that person beginning Work on the Project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the Project for the duration of the Project;

iii. Provide the Contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the Project;

iv. Obtain from each other person with whom it contracts, and provide to the Contractor:

1. A certificate of coverage, prior to the other person beginning Work on the Project; and
2. A new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the Project;
3. Retain all required certificates of coverage on file for the duration of the Project and for one (1) year thereafter;
4. Notify the Owner in writing by certified mail or personal delivery, within ten (10) days after the person knew, or should have known, of any change that materially affects the provision of coverage of any person providing services on the Project; and
5. Contractually require each person with whom it contracts to perform as required by items 1-4, with the certificates of coverage to be provided to the person for whom they are providing services.

l. By signing this contract or providing or causing to be provided a certificate of coverage, the Contractor is representing to the Owner that all employees of the Contractor who will provide services on the Project will be covered by Workers' Compensation coverage for the duration of the Project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the Commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the Contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

m. The Contractor's failure to comply with any of these provisions is a breach of contract by the Contractor that entitles the Owner to declare the contract void if the Contractor does not remedy the breach within ten (10) days after receipt of notice of breach from the Owner.

n. The coverage requirement recited above does not apply to sole proprietors, partners, and corporate officers who are excluded from coverage in an insurance policy or certificate of authority to self-insure that is delivered, issued for delivery, or renewed on or after January 1, 1996. 28 TAC 110.110(i).

9. The Owner and Contractor shall waive all rights against (1) each other and the Contractors, Subcontractors, agents and employees each of the other, and (2) the Architect and separate Contractors, if any, and their contractors, Subcontractors, agents and employees, for damages caused by fire or other perils to the extent covered by property insurance applicable to the Work. The foregoing waiver afforded the Architect, his agents and employees shall not extend to the

liability imposed by other portions of the Agreement. The Owner or the Contractor, as appropriate, shall require of the Architect, separate contractors, contractors and Subcontractors by appropriate agreements, written where legally required for validity, similar waivers, each in favor of all other parties enumerated in this Exhibit A.

Part 2: PERFORMANCE BOND AND PAYMENT BOND

1. The Contractor is required, as a condition precedent to the execution of the Contract, to execute a PERFORMANCE BOND in the form required by TEXAS STATUTES, in an amount equal to ONE HUNDRED PERCENT (100%) of the Contract Sum.
2. The Contractor is required, as a condition precedent to the execution of the Contract, to execute a PAYMENT BOND in the form required by TEXAS STATUTES, in an amount equal to ONE HUNDRED PERCENT (100%) of the Contract Sum as security for payment of all persons performing labor and furnishing materials in connection with this Contract. (Bonding Company is to furnish such forms). All bonds shall name the Owner as additional Obligee.
3. The Payment and Performance Bond shall meet requirements of Chapter 2253 of the Texas Governmental Code. All bonds shall be issued by a surety company licensed, listed and authorized to issue bonds in the State of Texas by the Texas Department of Insurance. The surety company may be required by the Owner to have a rating of not less than "B" in the latest edition of Best's Insurance Reports, Property-Casualty. The surety company shall provide, if requested, information on bonding capacity, other projects under coverage and shall provide proof to establish adequate financial capacity for this Project.
    a. Should the bond amount be in excess of ten percent (10%) of the surety company's capital and surplus, the surety company issuing the bond shall certify that the surety company has acquired reinsurance, in a form and amount acceptable to the Owner, to reinsure the portion of the risk that exceeds ten percent (10%) of the surety company's capital and surplus with one or more reinsurers who are duly authorized and admitted to do business in Texas and that amount reinsured by an reinsurer does not exceed ten percent (10%) of the reinsurer's capital and surplus.
    b. The Sureties shall promptly file a signed copy of the Contract, Performance, and Payment Bonds with the Owner in full compliance with Chapter 2253 of the Texas Governmental Code or, in the case of a Construction Manager, as required by Article 8 of the A133-2009 as modified by the Parties.
4. All bonds will be reviewed by the Architect for compliance with the Contract Documents prior to execution of the contract. In the event that the Architect has any questions concerning the sufficiency of the bonds, the bonds will be referred to the Owner or the Owner's representative for review and decision.
5. All bonds shall be originals. The Contractor shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy of the Power-of-Attorney. The name, address, and telephone number of a contact person for the bonding company shall be provided.
6. Upon the request in writing of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the contract, the Contractor shall promptly furnish a copy of the bonds or shall permit a copy to be made.
7. Bonds shall be signed by an agent resident in the State of Texas and the date of the bond shall be the date of execution of the contract. If at any time during the continuance of the contract, the surety of the Contractor's bonds becomes insufficient, Owner shall have the right to require

additional and sufficient sureties which the Contractor shall furnish to the satisfaction of the Owner within ten (10) business days after notice to do so. In default thereof, the Contractor may be suspended, and all payment or money due to the Contractor withheld.

8. By inclusion of this Section 8 in the Contract Documents, the surety which issues the bonds is hereby notified that the Owner, the Architect, and their agents and employees do not represent and will not be responsible for the surety's interests during the course of the Work. To protect its interests, the surety shall have the right to attend pay estimate meetings, review Applications for Payment when requested in writing by them, comment upon and make recommendations regarding payments, and inspect the Work in the presence of the Contractor and the Architect. By providing the bonds for the Work, the surety shall and hereby waives any cause of action against the Owner, the Architect, their agents and employees, for any loss suffered by the surety by reason of overpayment of any amounts to the Contractor, unless such is a direct result of a fraudulent or grossly negligent act committed by such party.

Part 3: INSURANCE REQUIRED OF PROFESSIONAL SERVICE PROVIDERS CONTRACTED TO THE CONTRACTOR

1. The Architect shall provide and maintain the following insurance with indemnification limits not less than the amounts indicated, until termination of this Agreement. The Architect and Consultants shall not commence work until all required insurance coverage has been obtained and such insurance has been reviewed and accepted by the Owner. Certificates of Insurance on the current ACORD form shall be issued to the Owner showing all required insurance coverage.

Insurance Required	Limit Required
Automobile Liability Insurance covering Any Auto	$1,000,000.00 Combined Single Limit (Ea. Accident)
Comprehensive (Commercial) General Liability insurance including Products, Completed Operations, Independent Contractors, Broad Form Property Damage, Pollution and Blanket Contractual Liability coverage. Any XCU exclusions to be removed when underground work is performed.	$1,000,000.00 Occurrence $2,000,000.00 Aggregate $1,000,000.00 Personal and Advertising Injury $500,000.00 Fire Damage $10,000.00 Medical Payments Per Project Aggregate. Evidence of coverage must be shown on certificates of insurance
Professional Errors and Omissions Liability Insurance required for all licensed or certified professionals, (e.g., all Architects and Engineers)	$3,000,000.00 Per Claim and Per Occurrence $5,000,000.00 Annual Aggregate Retroactive to date preceding date of contract must be shown in the Comments/Remarks Section of the ACORD form. Professional Errors and Omissions Liability Insurance shall be maintained for three (3) years past substantial completion of construction contract, including last completed phase for phased project delivery. If coverage is cancelled or non-renewed prior to contract completion date, the Architect shall purchase "Extended Reporting Period" coverage for three (3) year period.

Workers Compensation insurance with limits to comply with the requirements of the Texas Workers' Compensation Act	Statutory Limits
Employers Liability Insurance	$1,000,000.00 Each Accident $1,000,000.00 Disease – Each Employee $1,000,000.00 Disease – Policy Limit
Umbrella or Excess Liability insurance	$5,000,000.00 Each Occurrence $5,000,000.00 Aggregate

2. The required insurance must be written by companies acceptable to the Owner. The required insurance policies, except for professional liability insurance and worker's compensation insurance, shall and must name the Owner and Program Manager, its officials, employees, and officers as additional insureds. The required insurance policies shall contain no specific limitations on the coverage afforded the Additional Insureds.

3. All insurance and limits of liability required herein shall be in effect as of the earlier of the effective date of this Agreement or the date of the commencement of Architect's services in relation to the Project and shall remain in effect continuously throughout the term of this Agreement or for such longer periods as are required herein. In the case of Professional Liability insurance, the required coverage and limits of liability shall remain in effect for a minimum period of two (2) years following the completion of professional services hereunder.

4. If the insurance is written on a claims-made form, coverage shall be continuous (by renewal or extended reporting period) for not less than thirty—six (36) months following completion of this Agreement and acceptance by Owner

5. The Workers' Compensation insurance policy required herein shall contain a waiver of subrogation in favor of Owner, its officials, employees, and officers, whether by way of an approved endorsement or otherwise.

6. The Architect shall be responsible for verifying insurance coverage in the required amounts of all Consultants or other professionals employed by or used by the Architect and obtaining the required certificates of insurance before any such Consultants or other professionals begin work on the Project.

7. The insurance policies required by this Agreement shall be endorsed to reflect that the Architect's insurance coverage is primary over any other applicable insurance coverage held by Owner.

8. Insurance provided pursuant to this Section shall be considered a part of the Architect's basic services and shall not be a Reimbursable Expense.

9. Certificates of insurance acceptable to the Owner and naming the Owner, its officials, employees, and officers as additional insureds shall be filed with the Owner prior to commencement of the Architect's services or the services of consultants to the Architect or other professionals employed or used by Architect in relation to the Project, and thereafter upon renewal or replacement of each required *policy* of insurance. These certificates and the insurance policies required herein shall

contain a provision that coverages afforded under the policies will not be canceled, non-renewed, allowed to expire, or materially changed until at least 30 days' prior written notice has been given to the Owner.

10. The Architect shall notify Owner in writing and by certified mail or personal delivery, within ten (10) days after the Architect knew or should have known of any change that materially affects the provision of the required insurance coverages of any person providing services on the Project.

11. Because the Architect will be performing on-site services and observations, a copy of a certificate of insurance, a certificate of authority to self-insure issued by the Texas Workers' Compensation Commission, or a coverage agreement (TWCC-81, TWCC-82, or TWCC-84), showing statutory worker's compensation coverage for the Architect and its employees providing services on the Project is required for the duration of the Project.

12. Duration of the Project includes the time from the beginning of the Work on the Project until the Architect's work on the Project has been completed and accepted by the Owner.

13. Employees providing services on the Project include all persons or entities *employed* or contracted by the Architect and performing all or part of the services the Architect has undertaken to perform on the Project, that furnishes persons to provide services on the Project.

14. If coverage period shown on the Architect's current certificate of coverage ends during the duration of the Project, the Architect must, prior to the end of the coverage period, file a new certificate of coverage with the Owner showing that coverage has been extended.

15. The Architect shall obtain from each person providing services on the Project, and provide to the Owner:
    a. .A certificate of coverage, prior to that person beginning work on the Project, so Owner will have on file certificates of coverage showing coverage for all persons providing services on the Project.
    b. No later than seven (7) days after receipt by the Architect, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the Project.

16. By signing this contract or providing or causing to be provided a certificate of coverage, the Architect is representing to the Owner that all employees of the Architect who will provide services on the Project will be covered by workers' compensation coverage for the duration of the Project, that the coverage will be based on proper reporting of classification codes and *payroll* amounts, and that all coverage agreements will be filed with the appropriate insurance carrier, or, in the case of a self-insured, with the commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the Architect to administrative penalties, criminal penalties, or other civil actions.

17. The Architect's failure to comply with any of the provisions in this Part 3 and its subparts is a material breach of contract by the Architect that entitles the Owner to immediately declare the contract void and terminate this Agreement.

18. All Engineers and other Consultants retained to work for Architect or retained at Architect's expense shall carry the same amounts under the same conditions as described in this Part 3 and its subparts.

MORE THAN ARCHITECTS

ADDENDUM

NO. 2

TO THE DRAWINGS AND THE PROJECT MANUAL

PROJECT NAME: Tomball High School #3

CLIENT NAME: Tomball ISD

LOCATION: Tomball, TX

PROJECT NUMBER: 1940-01-01

PROPOSAL DATE: Tuesday, December 19th, 2023, 1:30 PM

ADDENDUM DATE: Friday, November 17th, 2023

For additional information regarding this project, contact Caitlin Munch at 915.588.9548.

11/17/2023

THIS ADDENDUM INCLUDES:

Civil Items	0 Items
Landscape Items	0 Items
Structural Items	0 Items
Architectural Items	2 Item
Foodservice Items	0 Items
Plumbing Items	20 Items
Mechanical Items	38 Items
Electrical Items	28 Items
Technology Items	24 Items
Appendix Items	1 Item

AND ALL ATTACHED REVISED DRAWING REFERENCES IN THE ADDENDUM

Huckabee

Project Name: Tomball High School #3
Client: Tomball ISD
Tomball, TX
Project Number: 1940-01-01

11/17/2023

ARCHITECTURAL ITEMS FOR ADDENDUM NO. 2

NOTICE TO PROPOSERS:

A. This Addendum shall be considered part of the contract documents for the above-mentioned project as though it had been issued at the same time and incorporated integrally therewith. Where provisions of the following supplementary data differ from those of the original contract documents, this Addendum shall govern and take precedence.
B. Proposers are hereby notified that they shall make any necessary adjustments in their estimate on account of this Addendum. It will be construed that each Proposer's proposal is submitted with full knowledge of all modifications and supplemental data specified therein. Acknowledge receipt of this addendum in the space provided on the proposal form. Failure to do so may subject Proposer to disqualification.

REFERENCE IS MADE TO THE DRAWINGS AND THE PROJECT MANUAL AS NOTED:

PROJECT MANUAL:

AD No 2, Arch. Item 1: To the Specifications section 08 5000, "Translucent Wall and Roof Assemblies"
Specification section added in its entirety.

DRAWINGS:

AD No 2, Arch. Item 2: To the Drawings, Sheets G2.00.1-2.00.7, "HCFCR,"
Sheets removed in their entirety.

END OF ARCHITECTURAL ADDENDUM

SECTION 08 4500
TRANSLUCENT WALL AND ROOF ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes the translucent high impact sandwich panel system and accessories as shown and specified. Work includes providing and installing:
   1. 2 □ " factory prefabricated structural translucent sandwich panels
   2. Aluminum installation system

1.02 SUBMITTALS

A. Submit manufacturer's product data. Include construction details, material descriptions, profiles and finishes of canopy components.

B. Submit shop drawings. Include elevations and details.

C. Submit manufacturer's color charts showing the full range of colors available for factory-finished aluminum.
   1. When requested, submit samples for each exposed finish required, in same thickness and material indicated for the work and in size indicated below. If finishes involve normal color variations, include sample sets consisting of two or more units showing the full range of variations expected.
      a. Sandwich panels: 14" x 28" units
      b. Factory finished aluminum: 5" long sections

D. Submit Installer Certificate, signed by installer, certifying compliance with project qualification requirements.

E. Submit product reports from a qualified independent testing agency indicating each type and class of panel system complies with the project performance requirements, based on comprehensive testing of current products. Previously completed reports will be acceptable if for current manufacturer and indicative of products used on this project.
   1. Reports required are:
      a. International Building Code Evaluation Report
      b. Flame Spread and Smoke Developed (UL 723) - Submit UL Card
      c. Burn Extent (ASTM D 635)
      d. Color Difference (ASTM D 2244)
      e. Impact Strength (UL 972)
      f. Bond Tensile Strength (ASTM C 297 after aging by ASTM D 1037)
      g. Bond Shear Strength (ASTM D 1002)
      h. Beam Bending Strength (ASTM E 72)
      i. Fall Through Resistance (ASTM E 661)
      j. Insulation U-Factor (NFRC 100)
      k. Solar Heat Gain Coefficient (NFRC or Calculations)
      l. Class A Roof Covering Burning Brand (ASTM E 108)
      m. UL Listed Class A Roof System (UL 790) - Submit UL Card
      n. LEED Credits

1.03 QUALITY ASSURANCE

A. Manufacturer's ualifications
   1. Material and products shall be manufactured by a company continuously and regularly employed in the manufacture of specified materials for a period of at least ten consecutive years and which can show evidence of those materials being satisfactorily used on at least six projects of similar size, scope and location. At least three of the projects shall have been in successful use for ten years or longer.

2. Panel system must be listed by an ANSI accredited Evaluation Service, which requires quality control inspections and fire, structural and water infiltration testing of sandwich panel systems by an accredited agency.
3. uality control inspections shall be conducted at least once each year and shall include manufacturing facilities, sandwich panel components and production sandwich panels for conformance with AC177 “Translucent Fiberglass Reinforced Plastic (FRP) Faced Panel Wall, Roof and Skylight Systems” as issued by the ICC-ES.

B. Installer’s ualifications: Installation shall be by an experienced installer, which has been in the business of installing specified systems for at least two consecutive years and can show evidence of satisfactory completion of projects of similar size, scope and type.

1.04 PERFORMANCE REQUIREMENTS

A. The manufacturer shall be responsible for the configuration and fabrication of the complete canopy panel system.
1. When requested, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Structural Loads; Provide canopy system capable of handling the following loads:
a. Live Load: 20 PSF
b. Snow Load: 5 PSF; Drift Load: 20 PSF
c. Wind Load: 25 PSF (ASD)

1.05 DELIVERY STORAGE AND HANDLING

A. Deliver panel system, components and materials in manufacturer's standard protective packaging.

B. Store panels on the long edge; several inches above the ground, blocked and under cover in accordance with manufacturer's storage and handling instructions.

1.06 WARRANTY

A. Submit manufacturer's and installer's written warranty agreeing to repair or replace panel system work, which fails in materials or workmanship within one year of the date of delivery. Failure of materials or workmanship shall include excessive deflection; deterioration of finish on metal in excess of normal weathering; and defects in accessories, translucent sandwich panels, and other components of the work.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Kalwall: www.kalwall.com.

B. Kingspan Light + Air / CPI Daylighting: www.cpidaylighting.com

C. Major Industries, Inc: www.majorskylights.com.

D. Substitutions: See Section 01 6000 - Product Requirements.

2.02 PANEL COMPONENTS

A. High Impact Face Sheets
1. Translucent faces (Exterior and Interior): Manufactured from glass fiber reinforced thermoset resins, formulated specifically for architectural use.
a. Thermoplastic (e.g. polycarbonate, acrylic) faces are not acceptable.
b. Face sheets shall not deform, deflect or drip when subjected to fire or flame.
c. Flame spread: Underwriters Laboratories (UL) listed, which requires periodic unannounced retesting, with flame spread rating no greater than 25 when tested in accordance with UL 723.
d. Burn extent by ASTM D 635 shall be no greater than 1”.
e. Exterior face sheets:

1) Color stability: Full thickness of the face sheets shall not change color more than 3 CIE Units DELTA E by ASTM D 2244 after 3 years outdoor South Florida weathering at 5° facing south, determined by the average of at least three white samples with and without a protective film or coating to ensure long-term color stability. Color stability shall be unaffected by abrasion or scratching.
2) Strength: Exterior face sheet shall be uniform in strength, impenetrable by hand held pencil and repel an impact minimum of 70 ft. lbs. without fracture or tear when impacted by a 3-1/4" diameter, 5 lb. free-falling ball per UL 972.

f. Appearance:
1) Exterior face sheets: Smooth, .070 thick and "Super Weathering White" in color,
2) Interior face sheets: Smooth, 0.45 and "white" in color,.
3) Face sheets shall not vary more than □ 10% in thickness and be uniform in color.

B. Grid Core
1. Aluminum I-beam grid core shall be of 6063-T6 or 6005-T5 alloy and temper with provisions for mechanical interlocking of muntin-mullion and perimeter. Width of I-beam shall be no less than 7/16".

C. Laminate Adhesive
1. Heat and pressure resin type adhesive engineered for structural sandwich panel use, with minimum 25-years field use. Adhesive shall pass testing requirements specified by the International Code Council "Acceptance Criteria for Sandwich Panel Adhesives".
2. Minimum tensile strength of 750 PSI when the panel assembly is tested by ASTM C 297 after two exposures to six cycles each of the aging conditions prescribed by ASTM D 1037.
3. Minimum shear strength of the panel adhesive by ASTM D 1002 after exposure to four separate conditions:
a. 50% Relative Humidity at 68° F: 540 PSI
b. 182° F: 100 PSI
c. Accelerated Aging by ASTM D 1037 at room temperature: 800 PSI
d. Accelerated Aging by ASTM D 1037 at 182° F: 250 PSI

2.03 PANEL CONSTRUCTION

A. Provide non-thermally broken sandwich panels of flat fiberglass reinforced translucent face sheets laminated to a grid core of mechanically interlocking I-beams. The adhesive bonding line shall be straight, cover the entire width of the I-beam and have a neat, sharp edge.
1. Thickness: 2-3/4"
2. Light transmission: 16%
3. Panel U-factor: 29
4. Grid pattern: Nominal size: 12x 24; Pattern "Shoji"

B. Standard panels shall deflect no more than 1.9" at 30 PSF in 10' 0" span without a supporting frame by ASTM E 72.

C. Standard panels shall withstand 1200° F fire for minimum one hour without collapse or exterior flaming.

2.04 BATTENS AND PERIMETER CLOSURE SYSTEM

A. Closure system:
1. Extruded aluminum 6063-T6 and 6063-T5 alloy and temper clamp-tite screw type closure system.

B. Sealing tape: Manufacturer's standard, pre-applied to closure system at the factory under controlled conditions.

C. Fasteners: 300 series stainless steel screws for aluminum closures, excluding final fasteners to the building.

D. Finish:
   1. Manufacturer's factory applied finish, which meets the performance requirements of AAMA 2604. Color to be selected from manufacturer's standards.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Installer shall examine substrates, supporting structure and installation conditions.

B. Do not proceed with panel installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Metal Protection:
   1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
   2. Where aluminum will contact concrete, masonry or pressure treated wood, protect against corrosion by painting contact surfaces with bituminous paint or method recommended by manufacturer.

3.03 INSTALLATION

A. Install the system in accordance with the manufacturer's suggested installation recommendations and approved shop drawings.
   1. Anchor component parts securely in place by permanent mechanical attachment system.
   2. Accommodate thermal and mechanical movements.
   3. Set perimeter framing in a full bed of sealant compound, or with joint fillers or gaskets to provide weather-tight construction.

B. Install joint sealants at perimeter joints and within the panel system in accordance with manufacturer's installation instructions.

3.04 CLEANING

A. Clean the canopy system interior and exterior, immediately after installation.

B. Refer to manufacturer's written recommendations.

END OF SECTION 10 73 00

Project Name: Tomball High School #3
Client: Tomball ISD
Tomball, TX
Project Number: 1940-01-01

FIRE PROTECTION, PLUMBING, MECHANICAL, ELECTRICAL AND TECHNOLOGY ITEMS FOR ADDENDUM NO. 2

NOTICE TO PROPOSERS:

A. This Addendum shall be considered part of the contract documents for the above-mentioned project as though it had been issued at the same time and incorporated integrally therewith. Where provisions of the following supplementary data differ from those of the original contract documents, this Addendum shall govern and take precedence.
B. Proposers are hereby notified that they shall make any necessary adjustments in their estimate on account of this Addendum. It will be construed that each Proposer's proposal is submitted with full knowledge of all modifications and supplemental data specified therein. Acknowledge receipt of this addendum in the space provided on the proposal form. Failure to do so may subject Proposer to disqualification.

REFERENCE IS MADE TO THE DRAWINGS AND THE PROJECT MANUAL AS NOTED:

PROJECT MANUAL:

AD No 2, MEPT, Item 1: Division 21, 22, 23, 26, 27 & 28 specifications are being reissued in entirety.

END OF MEPT ADDENDUM

Huckabee

SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Above ground piping.
B. Escutcheons.
C. Mechanical couplings.
D. Pipe hangers and supports.
E. Pipe sleeves.
F. Pipe sleeve-seal systems.
G. Pressure gauges.

1.02 RELATED REQUIREMENTS

A. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.03 REFERENCE STANDARDS

A. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
B. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.
C. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - ualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
D. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
E. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
F. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250 2021.
G. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
H. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).
I. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
J. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use 2021.
K. AWWA C606 - Grooved and Shouldered Joints 2022.
L. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.
C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
D. Installer's qualification statement.

E. Project Record Documents: Record actual locations of components and tag numbering.

1.05 QUALITY ASSURANCE

A. Delegated-Design Submittal: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

B. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers, with labeling in place.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Sprinkler-based System:
   1. Comply with NFPA 13.
   2. See Section 21 1300.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

C. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

A. Steel Pipe: ASTM A795 Schedule 10 or ASTM A795 Schedule 40, black.
   1. Steel Fittings: ASME B16.5 steel flanges and fittings.
   2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
   3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.03 PIPE SLEEVES

A. Vertical Piping:
   1. Sleeve Length: 1 inch above finished floor.
   2. Provide sealant for watertight joint.
   3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
   4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

2.04 PIPE SLEEVE-SEAL SYSTEMS

A. Modular Mechanical Seals:
   1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
   2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
   3. Size and select seal component materials in accordance with service requirements.
   4. Service Requirements:

a. Underground, buried, and wet conditions.

5. Glass-reinforced plastic pressure end plates.

B. Wall Sleeve: PVC material with waterstop collar, and nailer end caps.

C. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch thick.

D. Pipeline-Casing Seals:
1. Coated-metallic boltless casing-spacer for 4 inch carrier pipe.
2. Coated-metallic boltless modular seal for 6 inch carrier pipe.
3. Carbon steel band with riser for 12 inch carrier pipe.
4. End Seals: 1/8 inch, pull-on type, rubber or synthetic rubber based.

2.05 ESCUTCHEONS

A. Material:
1. Metals and Finish: Comply with ASME A112.18.1.

B. Construction:
1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.06 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.

B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.

C. Vertical Support: Steel riser clamp.

2.07 MECHANICAL COUPLINGS

A. Manufacturers:
1. Anvil International: www.anvilintl.com/#sle.
2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
3. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
4. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.
5. Substitutions: See Section 01 6000 - Product Requirements.

B. Rigid Mechanical Couplings for Grooved Joints:
1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.
7. Provide stops for direct stab installation without field assembly.

2.08 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove scale and foreign material, from inside and outside, before assembly.

B. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.

B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

C. Install piping to conserve building space, to not interfere with use of space and other work.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

G. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

H. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.

I. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

J. Manufactured Sleeve-Seal Systems:
   1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
   2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
   3. Locate piping in center of sleeve or penetration.
   4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
   5. Tighten bolting for a watertight seal.
   6. Install in accordance with manufacturer's recommendations.

K. Escutcheons:
   1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
   2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
   3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

SECTION 21 0523
GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Two-piece ball valves with indicators.

B. Bronze butterfly valves with indicators.

C. Iron butterfly valves with indicators.

D. Check valves.

E. Iron OS&Y gate valves.

F. Trim and drain valves.

1.02 RELATED REQUIREMENTS

A. Section 21 0553 - Identification for Fire Suppression Piping and Equipment.

B. Section 21 1200 - Fire-Suppression Standpipes.

C. Section 21 1300 - Fire-Suppression Sprinkler Systems.

D. Section 21 1339 - Foam-Water Systems.

E. Section 33 1416 - Site Water Utility Distribution Piping.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

C. ASME B31.9 - Building Services Piping 2020.

D. AWWA C606 - Grooved and Shouldered Joints 2022.

E. FM (AG) - FM Approval Guide Current Edition.

F. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 1091 - Standard for Butterfly Valves for Fire-Protection Service Current Edition, Including All Revisions.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
   1. Automated Sprinkler Systems:
      a. Indicator posts.
      b. Valves:
         1) Gate valves.

B. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B1.20.1 for threads on threaded-end valves.
   3. ASME B31.9 for building services piping valves.

C. Comply with AWWA C606 for grooved-end connections.

D. Comply with NFPA 13 for valves.

E. Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.02 TWO-PIECE BALL VALVES WITH INDICATORS

A. UL 1091, except with ball instead of disc and FM (AG) standard listing for indicating valves (butterfly or ball type), Class Number 1112.

B. Description:
   1. Minimum Pressure Rating: 175 psig.
   2. Body Design: Two piece.
   3. Body Material: Forged brass or bronze.
   4. Port Size: Full or standard.
   5. Seat: PTFE.
   6. Stem: Bronze or stainless steel.
   7. Ball: Chrome-plated brass.
   8. Actuator: Worm gear or traveling nut.

2.03 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Minimum Pressure Rating: 175 psig.

B. Body Material: Bronze.

C. Seat: EPDM.

D. Stem: Bronze or stainless steel.

E. Disc: Bronze with EPDM coating.

F. Actuator: Worm gear or traveling nut.

G. Supervisory Switch: Internal or external.

2.04 IRON BUTTERFLY VALVES WITH INDICATORS

A. Minimum Pressure Rating: 175 psig.

B. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, polyamide, or coating.

C. Seat: EPDM.

D. Stem: Stainless steel.

E. Disc: Ductile iron, nickel plated.

F. Actuator: Worm gear or traveling nut.

G. Supervisory Switch: Internal or external.

H. Body Design: Grooved-end connections.

2.05 CHECK VALVES

A. Minimum Pressure Rating: 175 psig.

B. Type: Center guided check valve.

C. Body Material: Cast iron, ductile iron.

D. Center guided check with elastomeric seal.

E. Hinge Spring: Stainless steel.

F. End Connections: Flanged, grooved, or threaded.

2.06 IRON OS&Y GATE VALVES

A. Maximum Working Pressure: 175 psi.

B. Body and Bonnet Material: Cast or ductile iron.

C. Wedge: Cast or ductile iron, or bronze with elastomeric coating.

D. Stem: Brass, bronze, or stainless steel.

E. Packing: Non-asbestos PTFE.

F. Supervisory Switch: External.

2.07 TRIM AND DRAIN VALVES

A. Ball Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Design: Two piece.
      c. Body Material: Forged brass or bronze.
      d. Port Size: Full or standard.
      e. Seat: PTFE.
      f. Stem: Bronze or stainless steel.
      g. Ball: Chrome-plated brass.
      h. Actuator: Hand-lever.

B. Angle Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Material: Brass or bronze.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
   1. Description:
      a. Pressure Rating: 175 psig.
      b. Body Material: Bronze with integral seat and screw-in bonnet.
      c. Ends: Threaded.
      d. Stem: Bronze.
      e. Disc Holder and Nut: Bronze.
      f. Disc Seat: Nitrile.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with specific valve installation requirements and application in the following Sections:
   1. Section 21 1200 for application of valves in fire-suppression standpipes.
   2. Section 21 1300 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
   3. Section 21 1339 for application of valves in foam-water, fire-suppression sprinkler systems.

4. Section 33 1416 for application of valves in fire-suppression water-service piping outside the building.

B. Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
   1. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves in horizontal piping installed with stem at or above the pipe center.

D. Position valves to allow full stem movement.

E. Install valve tags. Comply with Section 21 0553 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION

SECTION 21 0553
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Automatic Controls: Tags.

B. Control Panels: Nameplates.

C. Major Control Components: Nameplates.

D. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.02 NAMEPLATES

A. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: White.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

2.04 PIPE MARKERS

A. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wet-pipe sprinkler system.

B. Dry-pipe sprinkler system.

C. System design, installation, and certification.

D. Fire department connections.

1.02 REFERENCE STANDARDS

A. FM (AG) - FM Approval Guide Current Edition.

B. NFPA 13 - Standard for the Installation of Sprinkler Systems Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies 2022, with Errata.

D. NFPA 1963 - Standard for Fire Hose Connections 2019.

E. UL (DIR) - Online Certifications Directory Current Edition.

F. UL 405 - Standard for Safety Fire Department Connection Devices Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

C. Shop Drawings:
   1. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
   2. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Architect.

D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.

E. Designer's qualification statement. The designer shall be a licensed individual and certify the following:
   1. The layout is within the scope of the applicable prescriptive codes or standards, such as the National Fire Protection Association (NFPA) Standard 13 "Standard for the Installation of Sprinkler Systems" as specified, or adopted by the state or local jurisdiction.
   2. The licensed individual currently holds a valid Responsible Managing Employee License (RME) issued by the Texas State Fire Marshal's Office, in accordance with the Texas Insurance Code Article 5.43-3.
   3. The licensed individual is certified to a minimum Level III, in the subfield of "Automatic Sprinkler Systems Layout", through the National Institute for Certification in Engineering Technologies (NICET).
   4. Upon completion of the installation a licensed individual, where given the specific authority by Texas Statute, will certify in writing that the installation meets the standards provided for by law and/or is in compliance with the plans and specifications of the licensed professional engineer.

F. Installer's qualification statement.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
   3. Sprinkler Wrenches: For each sprinkler type.

H. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.04 QUALITY ASSURANCE

A. Comply with FM (AG) requirements.

B. Designer ualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

C. Equipment and Components: Provide products that bear FM (AG) label or marking.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sprinklers, Valves, and Equipment:
   1. Anvil International: www.anvilintl.com/#sle.
   2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
   3. Viking Corporation: www.vikinggroupinc.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

2.02 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for entire building.

B. Occupancy: Ordinary hazard, Group 1; comply with NFPA 13.
   1. Building Service Areas: Ordinary hazard, Group 1; comply with NFPA 13.
   2. Electrical Equipment Rooms: Ordinary hazard, Group 1; comply with NFPA 13.
   3. General Storage Areas: Ordinary hazard, Group 1; comply with NFPA 13.
   4. All other areas: Light hazard; comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.

D. Provide fire department connections where indicated.

E. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.03 SPRINKLERS

A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
   1. Response Type: uick.
   2. Coverage Type: Standard.
   3. Finish: Enamel, color White unless noted otherwise .
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type: Pendant type.
   1. Response Type: uick.
   2. Coverage Type: Standard.
   3.
   4. Fusible Link: Glass bulb type temperature rated for specific area hazard.

C. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
   1. Response Type: uick.
   2. Coverage Type: Standard.
   3. Fusible Link: Glass bulb type temperature rated for specific area hazard.

D. Dry Sprinklers: Concealed pendant type with matching push on escutcheon plate.
   1. Response Type: uick.
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

E. Flexible Drop System: Stainless steel, multiple use, open gate type.
   1. Application: Use to properly locate sprinkler heads.
   2. Include all supports and bracing.
   3. Provide braided type tube as required for the application.
   4. Manufacturers:
      a. FlexHead Industries, a brand of Anvil International: www.anvilintl.com/#sle.
      b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.

2.04 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.

B. Dry Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm, accelerator, and with the following additional capabilities and features:
   1. Activate electric alarm.
   2. Test and drain valve.

C. Electric Alarm: Electrically operated chrome plated gong with pressure alarm switch.

D. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts; rated 10 amp at 125 volt AC and 2.5 amp at 24 volt DC.

E. Fire Department Connections:
   1. Type: Free standing made of corrosion resistant metal complying with UL 405.
      a. Inlets: Two way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or Authority Having Jurisdiction. Brass caps with gaskets, chains, and lugs.
      b. Sleeve: Brass, 18 inches height.

2.05 AIR COMPRESSOR

A. Compressor: Single-unit, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Locate outside alarm gong on building wall as indicated.

D. Place pipe runs to minimize obstruction to other work.

E. Place piping in concealed spaces above finished ceilings.

F. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

G. Flush entire piping system of foreign matter.

H. Hydrostatically test entire system.

I. Require test be witnessed by Fire Marshal.

END OF SECTION

SECTION 22 0150
PLUMBING & PIPING MATERIALS & METHODS

PART 1 GENERAL

1.01 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 22.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.02 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

3.02 PIPE AND FITTING INSTALLATION

A. Plastic DWV piping shall be installed as addressed by IAPMO (UPC) code section on Expansion and Contraction. Any straight runs of plastic DWV piping exceeding 30 feet shall be installed to accommodate thermal expansion.

B. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Plumbing Contractor.

C. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

D. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

E. All pipes shall be reamed to full pipe diameter before joining.

F. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls when practical.

G. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

H. Provide 1/2" drain valves at all low points of each system to enable complete drainage.

I. Provide "Clearflow" dielectric waterways at all junctions of dissimilar metals in potable water systems.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

3.03 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping shall be covered whenever that system is not being worked on, i.e. end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping when the contractor is not on the jobsite.

3.04 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the plumbing equipment shall be by the plumbing contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.05 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe shall not exceed □ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes with sound insulation (batt or mineral wool) to within ½" of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping spec section for reposition finned element to be centered under windows as required.more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.06 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

C. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

D. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

E. Refer to Section 09 900, Painting for additional requirements.

3.07 ASBESTOS FREE BUILDING

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

END OF SECTION

SECTION 22 0513
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

1.02 REFERENCE STANDARDS

A. NEMA MG 1 - Motors and Generators 2021.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Baldor Electric Company/ABB Group; : www.baldor.com/#sle.

B. Regal-Beloit Corporation (Century); : www.centuryelectricmotor.com/#sle.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.03 APPLICATIONS

A. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

B. Motors located in exterior locations, direct drive axial fans, and dust collection systems: Totally enclosed type.

C. Motors located in in draw through cooling towers: Totally enclosed weatherproof epoxy-treated type.

2.04 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges.

B. Thermometers.

C. Pressure-temperature test plugs.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Bourdon Tube for Liquids and Gases:
   1. Dial Size and Cover: 4-1/2 inch diameter scale with polycarbonate window.
   2. Accuracy: ASME B40.100, adjustable commercial grade (D) with 5 percent of span.
   3. Process Connection: Lower-back, 1/4 inch NPT male except where noted.

2.02 THERMOMETERS

A. General:
   1. Product Compliance: ASTM E1.
   2. Lens: Clear glass, except where stated.
   3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
   4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.

B. Thermometers - Dial Type:
   1. Fixed: 5 inch diameter dial with black pointer, stainless steel case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch NPT stem.

2.03 PRESSURE-TEMPERATURE TEST PLUGS:

A. Size: 500 psi capacity; 1/2 inch MPT brass fitting with gasket, cap, and retaining strap for 1/8 inch pressure gauge or temperature probe.

B. Wetted Materials per Temperature Range:
   1. Up to 200 degrees F: Brass probe with neoprene core.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pressure gauges as follows:
   1. At Pumps: Place single gauge before strainer, suction side and discharge side.

B. Install thermometers as follows:

1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.

END OF SECTION

SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ball valves.

B. Butterfly valves.

C. Check valves.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).

B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.

D. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2022.

E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.

F. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.

G. ASME B31.9 - Building Services Piping 2020.

H. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).

I. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).

J. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).

K. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.

L. AWWA C606 - Grooved and Shouldered Joints 2022.

M. MSS SP-45 - Drain and Bypass Connections 2020.

N. MSS SP-67 - Butterfly Valves 2022.

O. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.

P. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.

. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

R. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

S. NSF 372 - Drinking Water System Components - Lead Content 2022.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

1.07 EXERCISE THE FOLLOWING PRECAUTIONS FOR HANDLING:

A. Handle large valves with sling, modified to avoid damage to exposed parts.

B. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable valve manufacturers are:
   1. NIBCO

2.02 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Shutoff: Ball, butterfly, gate.
   2. Dead-End: Single-flange butterfly (lug) type.
   3. Throttling: Provide ball.
   4. Swing Check (Pump Outlet):
      a. 2 inch and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

D. Low Pressure, Compressed Air Valves 150 psi or Less:
   1. 2 inch and Smaller:
      a. Ball: One piece, full port, brass with brass trim.
      b. Bronze Lift Check: Class 125, bronze disc.

E. Domestic, Hot and Cold Water Valves:
   1. 2 inch and Smaller:
      a. Ball: Two piece, full port, bronze with stainless-steel trim.
      b. Bronze Swing Check: Class 125, bronze disc.
   2. 2-1/2 inch and Larger:
      a. Iron, 2-1/2 inch to 4 inch: Provide with flanged ends.

b. Iron Ball: Class 150.
c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
d. Iron Grooved-End Butterfly: 175 CWP.
e. Iron Swing Check: Class 125, metal seats.

2.03 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Handwheel: Valves other than quarter-turn types.
2. Hand Lever: uarter-turn valves 6 inch and smaller except plug valves.

D. Insulated Piping Valves: With 2 inch stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Grooved End Connections: AWWA C606.

F. General ASME Compliance:
1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
2. Solder-joint Connections: ASME B16.18.
3. Building Services Piping Valves: ASME B31.9.

G. Potable Water Use:
1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

H. Valve Bypass and Drain Connections: MSS SP-45.

I. Source Limitations: Obtain each valve type from a single manufacturer.

2.04 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. WSP Rating: 150 psi.
3. WOG Rating: 600 psi.
4. Body: Forged bronze or dezincified-brass alloy.
5. Ends Connections: Pipe thread or solder.
6. Seats: PTFE.

2.05 IRON, BALL VALVES

A. Class 125, Full Port, Stainless Steel Trim:

1. Comply with MSS SP-72.
2. CWP Rating: 200 psi.
3. Body: ASTM A536 Grade 65-45-12, ductile iron.
4. End Connections: Flanged.
5. Seats: PTFE.
6. Stem: Stainless steel.
7. Ball: Stainless steel.
8. Operator: Lever with locking handle.
9. Manufacturers:
    a. NIBCO.

2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style; Bi-directional dead-end service without use of downstream flange:
1. Class 125, or Class 150 flanges.
2. Comply with MSS SP-67, Type I.
3. Lug Style, Service Pressure Ratings:
    a. 150 psi for sizes 14 to 24 inch.
    b. 150 psi for sizes 14 to 24 inch.
    c. Vacuum down to 29.9 in-Hg.
4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
5. Stem: One or two-piece stainless steel.
6. Seat: EPDM.
7. Disc: Aluminum-bronze.
8. Finish: Epoxy coated.
9. Operator: Lockable handle over direct-mount actuator base.
10. Manufacturers:
    a. NIBCO.

2.07 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 175 psi.
1. Comply with MSS SP-67, Type I.
2. Body: Coated ductile iron.
3. Stem: Two-piece stainless steel.
4. Disc: Coated ductile iron.
5. Disc Seal: EPDM.

2.08 BRONZE, LIFT CHECK VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
1. Comply with MSS SP-80, Type 1, Metal Disc to Metal Seat and Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 200 psi.
3. Design: Vertical flow.
4. Body: Comply with ASTM B61 or ASTM B62, bronze.
5. End Connections: Threaded.
6. Disc (Type 1): Bronze.
7. Manufacturers:
    a. NIBCO.

2.09 BRASS, INLINE CHECK VALVES

A. Class 150:
   1. Maximum Service Temperature: 250 degrees F.
   2. Body: Forged brass.
   3. Disc: Forged brass.
   4. Seal: PTFE, bubble-tight.
   5. End Connections: Press.
   6. Manufacturers:
      a. NIBCO.

2.10 BRONZE, SWING CHECK VALVES

A. General:
   1. Fabricate from dezincification resistant material.
   2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Class 125:
   1. Pressure and Temperature Rating: MSS SP-80, Type 3.
   2. Design: Y-pattern, horizontal or vertical flow.
   3. WOG Rating: 200 psi.
   4. Body: Bronze, ASTM B62.
   5. End Connections: Threaded.
   6. Disc: Bronze.
   7. Manufacturers:
      a. NIBCO.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

C. Install check valves where necessary to maintain direction of flow as follows:
   1. Lift Check: Install with stem plumb and vertical.
   2. Swing Check: Install horizontal maintaining hinge pin level.

END OF SECTION

SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prefabricated trapeze-framed systems.

B. Strut systems for pipe or equipment support.

C. Beam clamps.

D. Pipe hangers.

1.02 RELATED REQUIREMENTS

A. Section 05 5000 - Metal Fabrications.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

B. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
   1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

B. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

C. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

D. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

E. Materials for Metal Fabricated Supports: Comply with Section 05 5000.
   1. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
   2. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.

F. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.

2.02 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

A. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. MFMA-4 compliant, pre-fabricated, MSS SP-58 Type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
   2. Strut Channel or Bracket Material:
      a. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

B. Roof Piping Support System:
   1. Manufacturer: Eaton, Dura-Blok DB series or equal.
   2. Materials:
      a. Curb Base: Rubber and polyurethane prepolymer with a uniform load capacity of 500 punds per linear foot of support.
      b. Dimensions: 6 inch wide with height and length as required.
      c. Steel Frame: Steel, strut galvanized per ASTM A653/A653M or strut galvanized per ASTM A653/A653M for bridge series.
      d. Attaching Hardware: Zinc-plated threatded rod, nuts and attaching hardware per ASTM B633.

2.03 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

A. Strut Channels:
   1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   2. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

B. Hanger Rods:
   1. Threaded zinc-plated steel unless otherwise indicated.
   2. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Piping up to 1 inch: 1/4 inch diameter.
      c. Piping larger than 1 inch: 3/8 inch diameter.
      d. Trapeze Support for Multiple Pipes: 3/8 inch in length.

C. Channel Nuts:
   1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring as indicated on drawings.

2.04 BEAM CLAMPS

A. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.

B. C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.

C. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).

D. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.

E. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.

F. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish.

G. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

H. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

2.05 PIPE HANGERS

A. Band Hangers, Adjustable:
   1. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.

B. Clevis Hangers, Adjustable:
   1. Copper Tube: MSS SP-58 type 1, epoxy-plated copper.

2.06 PIPE CLAMPS

A. Riser Clamps:
   1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
   2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
   3. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

B. Extension Split Pipe Clamp:
   1. MSS SP-58 type 12, hinged split ring and yoke roller hanger with epoxy copper or plain finish.
   2. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
   3. Provide hanger rod and nuts of the same type and material for a given pipe run.
   4. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

C. Strut Clamps:
   1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

2.07 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

A. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

B. Stanchions:
   1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
   2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.

C. U-Bolts:
   1. MSS SP-58 type 24, carbon steel u-bolt for pipe support or anchoring.

D. Pipe Shields for Insulated Piping:
   1. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
   2. General Construction and Requirements:
      a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
      b. Shields Material: UV-resistant polypropylene with glass fill.
      c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
      d. Service Temperature: Minus 40 to 178 degrees F.
      e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

E. Pipe Supports:
   1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
   2. Liquid Temperatures Up to 122 degrees F:
      a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
      b. Support From Below: MSS SP-58 types 35 through 38.

F. Copper Pipe Supports:
   1. Manufacturers:
      a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
      b. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com/#sle.

2.08 ANCHORS AND FASTENERS

A. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

B. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

C. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

D. Hollow Masonry: Use toggle bolts.

E. Hollow Stud Walls: Use toggle bolts.

F. Steel: Use beam ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

G. Sheet Metal: Use sheet metal screws.

H. Wood: Use wood screws.

I. Plastic and lead anchors are not permitted.

J. Powder-actuated fasteners are not permitted.

K. Hammer-driven anchors and fasteners are not permitted.

L. Preset Concrete Inserts: Continuous metal strut channel and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   1. Channel Material: Use galvanized steel.
   2. Manufacturer: Same as manufacturer of metal strut channel framing system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

D. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

E. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

F. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.

END OF SECTION

SECTION 22 0533
HEAT TRACING FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Self-regulating parallel resistance electric heating cable.

B. Cable outer jacket markings.

C. Connection kits.

D. Accessories.

E. Controls.

1.02 REFERENCE STANDARDS

A. IEEE 515.1 - IEEE Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Commercial Applications 2022.

B. ITS (DIR) - Directory of Listed Products Current Edition.

C. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. UL (DIR) - Online Certifications Directory Current Edition.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with other trades to provide ground fault protection for electric heat tracing circuits as required by NFPA 70.

B. Coordinate the work with other trades to provide circuit breaker ratings suitable for installed circuit lengths.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for electric heat tracing.

C. Shop Drawings: Indicate electric heat tracing layout, electrical terminations, thermostats, controls, and branch circuit connections.

D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 SELF-REGULATING PARALLEL RESISTANCE ELECTRIC HEATING CABLE

A. Manufacturers:
   1. Chromalox, Inc: www.chromalox.com/#sle.
   2. Pentair: www.pentairthermal.com/#sle.
   3. Thermon Manufacturing Company: www.thermon.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Provide products listed, classified, and labeled by UL (DIR), ITS (DIR), or testing firm acceptable to authorities having jurisdiction (AHJ).

C. Factory Rating and Testing: Comply with IEEE 515.1.

D. Heating Element:

1. Provide pair of parallel No.16 tinned or nickel coated stranded copper bus wires embedded in cross linked conductive polymer core with varying heat output in response to temperature along its length.
2. Terminations: Waterproof, factory assembled, non-heating leads with connector at one end and water-tight seal at opposite end.
3. Capable of crossing over itself without overheating.

E. Insulated Jacket: Flame retardant polyolefin.

F. Cable Cover: Provide tinned copper and polyolefin outer jacket with UV inhibitor.

G. Maximum Power-On Operating Temperature: 150 degrees F.

H. Maximum Power-Off Exposure Temperature: 185 degrees F.

I. Electrical Characteristics:

2.02 CABLE OUTER JACKET MARKINGS

A. Name of manufacturer, trademark, or other recognized symbol of identification.

B. Catalog number, reference number, or model.

C. Month and year of manufacture, date coding, applicable serial number, or equivalent.

D. Agency listing or approval.

2.03 CONNECTION KITS

A. Provide power connection, splice/tee, and end seal kits compatible with the heating cable and without requiring cutting of the cable core to expose bus wires.

B. Provide with NEMA 4X rating for prevention of corrosion and water ingress.

2.04 ACCESSORIES

A. Provide Accessories As Indicated or As Required for Complete Installation, Including but Not Limited To:
1. Aluminum self-adhesive tape for attachment of heating cable to plastic piping.
2. Cable ties.
3. Silicone end seals and splice kits.
4. Installation clips.

2.05 CONTROLS

A. Pipe Mounted Thermostats:
1. Remote bulb unit with adjustable temperature range from 30 to 50 degrees F.
2. Remote bulb on capillary, resistance temperature device (RTD) or thermistor for direct sensing of pipe wall temperature.
3. Control Enclosure: Corrosion resistant and waterproof.

B. Line sensing high-limit temperature control and high-limit alarm.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping and equipment are ready to receive work.

B. Verify field measurements are as indicated on shop drawings.

C. Verify required power is available, in proper location, and ready for use.

3.02 PREPARATION

A. Clean exposed surfaces prior to installation.

B. Prepare surfaces using approved methods as recommended by manufacturer.

3.03 INSTALLATION

A. Install in accordance with manufacturer's written installation instructions.

B. Comply with installation requirements of IEEE 515.1 and NFPA 70, Article 427.

C. Apply heating cable linearly on pipe with fiberglass tape only after piping has successfully completed any required pressure testing.

D. Comply with applicable local building codes and requirements of authorities having jurisdiction.

E. Install all control wiring and accessories as required for a complete system.

F. Identification:

1. After thermal insulation installation, apply external pipeline decals to indicate presence of the thermal insulation cladding at intervals not to exceed 20 ft including cladding over each valve or other equipment that may require maintenance.

3.04 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals.

END OF SECTION

SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Pipe markers.

D. Ceiling tacks.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Schedules:
   1. Submit plumbing component identification schedule listing equipment, piping, and valves.
   2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
   3. Valve Data Format: Include id-number, location, function, and model number.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

A. Nameplates:
   1. Control panels, transducers, and other related control equipment products.

B. Pipe Markers: 3/4 inch diameter and higher.

2.02 NAMEPLATES

A. Description: Laminated piece with up to three lines of text.
   1. Letter Color: White.
   2. Letter Height: 1/4 inch.

2.03 TAGS

A. Flexible: Adhesive backed Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch in diameter.

B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

C. Valve Tag Chart: Typewritten 12-point letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

A. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
   1. Piping Color Coding:
      a. Domestic Hot & Hot Recirc: Bright Red
      b. Domestic Cold: Blue
      c. Natural Gas: Yellow

2.05 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. Plumbing Equipment: Yellow.
   2. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags in clear view and align with axis of piping

END OF SECTION

SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass fiber insulation.

B. Jacketing and accessories.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).

D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.

E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).

F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).

G. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

J. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

A. Maintain ambient conditions required by manufacturers of each product.

B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER INSULATION

A. Manufacturers:
   1. CertainTeed Corporation: www.certainteed.com/#sle.
   2. Johns Manville Corporation: www.jm.com/#sle.
   3. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

C. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

G. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

H. Insulating Cement: ASTM C449.

2.03 JACKETING AND ACCESSORIES

A. Aluminum Jacket:
   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   3. Joining: Longitudinal slip joints and 2 inch laps.
   4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

B. Aluminum-Foil Laminate Jacket:
   1. Factory-applied, pressure sensitive adhesive jacketing on paper release liner.
   2. Finish: Aluminum smooth.
   3. Comply with ASTM C1775.

C. Reinforced Tape:
   1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
   2. Comply with UL 723 or ASTM E84.
   3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

2.04 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

B. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

C. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

D. Indoor Vapor Barrier Mastic:
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

E. Outdoor Vapor Barrier Mastic:
1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Exposed Piping: Locate insulation and cover seams in least visible locations.

C. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

D. Inserts and Shields:
1. Application: Piping 1-1/2 inches diameter or larger.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

E. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

F. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

G. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES

A. Plumbing Systems:
1. Domestic Hot Water Supply:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All Pipe Sizes.
      2) Thickness: 2 inch.
2. Domestic Hot Water Recirculation:
   a. Glass Fiber Insulation:
      1) Pipe Size Range: All sizes.
      2) Thickness: 1 inch.
3. Roof Drain Bodies and Horizontal Piping:
   a. Glass Fiber, Flexible:
      1) Pipe Size Range: All sizes

2) Thickness: 1 inch

END OF SECTION

SECTION 22 0800
COMMISSIONING OF PLUMBING

PART 1 GENERAL

1.01 RELATED WORK

A. Division 23 - HVAC

B. Division 26 - Electrical

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of Plumbing systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for Plumbing systems and subsystems.

I. The CA will review operating and maintenance materials for Plumbing systems.

J. The CA will review phasing plans as provided by the GC relating to temporary use of Plumbing equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. Domestic Hot Water

B. Automatic Flush Valves

3.03 PLUMBING COMMISSIONING PLAN

A. Commissioning Team
   1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
      a. Program Manager (PrM)
      b. Facilities Management Division (FMD)
      c. Commissioning Agent (CA)
      d. Design Team (DT)
      e. General Contractor (GC)
      f. GC's Mechanical Contractor (MC)
      g. GC's Plumbing Contractor (PC)
      h. Controls Contractor (CC)
      i. Test and Balance Contractor (TABC)
      j. Electrical Contractor (EC)

B. Basis of Design Document
   1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.

2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings
1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)
1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists
1. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up
1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Plumbing equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Functional Performance Tests (FPT)
1. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
3. The Functional Performance Tests shall include Plumbing and related equipment.

a. Hot water system will be tested.
b. Heat Exchangers will be tested under relevant operating conditions.
c. DDC control systems will be tested as necessary.

4. Deferred Testing
   a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
   b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.
5. Rescheduled Functional Performance Test
   a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, contractor shall reimburse the owner for all additional costs the owner incurs as a result of the contractor's failure to be complete and/or to provide operating compliant systems for commissioning. Additional costs include but are not limited to additional fees of 1500.00 per day charged by the architect, engineer, construction manager and commissioning agent.
   b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed 1500.00 per day for the commissioning personnel's return trip.

H. Building Turn-Over / Owner Orientation / User Training
1. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Plumbing related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist the owner/user with warranty issues.
5. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. General Contractor (GC)
1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.

6. Assist the CA in monitoring the duct leakage testing.

B. GC's Plumbing Contractor (PC)
   1. Include cost for commissioning requirements in the contract price.
   2. Attend commissioning meetings scheduled by the CA.
   3. Verify proper installation and performance of all plumbing services provided.
   4. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of equipment.
   5. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
   6. Provide an electrical system technician to assist during verification and performance testing.
   7. Participate in the Functional Performance Tests as required to achieve design intent.
   8. Participate in the off-season mode testing as required to achieve design intent.
   9. Participate in O&M Training as required by project specifications.

END OF SECTION

SECTION 22 1005
PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary waste piping, buried within 5 feet of building.
B. Sanitary waste piping, above grade.
C. Chemical-resistant sanitary waste piping.
D. Domestic water piping, buried within 5 feet of building.
E. Domestic water piping, above grade.
F. Storm drainage piping, buried within 5 feet of building.
G. Storm drainage piping, above grade.
H. Natural gas piping, buried beyond 5 feet of building.
I. Natural gas piping, buried within 5 feet of building.
J. Natural gas piping, above grade.
K. Pipe flanges, unions, and couplings.
L. Pipe hangers and supports.
M. Ball valves.
N. Butterfly valves.
O. Pressure reducing valves.
P. Pressure relief valves.
. Pressure-temperature valves.
R. Strainers.

1.02 RELATED REQUIREMENTS

A. Section 22 0553 - Identification for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems 2015 (Reaffirmed 2020).
B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.
C. ASME B16.12 - Cast Iron Threaded Drainage Fittings 2019.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.
F. ASME B31.1 - Power Piping 2022.
G. ASME B31.9 - Building Services Piping 2020.
H. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2023.
I. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems 2023.
J. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.
K. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.

L. ASTM B32 - Standard Specification for Solder Metal 2020.

M. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

N. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.

O. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.

P. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.

. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.

R. ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings 2020.

S. ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings 2020.

T. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings 2020.

U. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.

V. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings 2020.

W. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing 2020.

X. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems 2019a.

Y. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

Z. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2023.

AA. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

BB. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 2021.

CC. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40 2017.

DD. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 2019.

EE. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 2023.

FF. ASTM F442/F442M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR) 2023.

GG. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings 2022.

HH. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing 2023.

II. AWWA C550 - Protective Interior Coatings for Valves and Hydrants 2017.

JJ. AWWA C606 - Grooved and Shouldered Joints 2022.

KK. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).

LL. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2021.

MM. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications 2020.

NN. FM 1680 - Approval Standard for Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/ Commercial and Residential 1989.

OO. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

PP. MSS SP-67 - Butterfly Valves 2022.

. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

RR. RSTEMP#10006704

SS. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

TT. NSF 372 - Drinking Water System Components - Lead Content 2022.

UU. PPI TR-4 - PPI HSB Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe 2021.

VV. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

B. Plenum-Installed Acid Waste Piping: Flame-spread index equal or below 25 and smoke-spread index equal or below 50 according to ASTM E84 or UL 723 tests.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY WASTE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.04 CHEMICAL-RESISTANT SANITARY WASTE PIPING

A. CPVC Pipe: ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M.
   1. Fittings: CPVC; ASTM D2846/D2846M, ASTM F437, ASTM F438, or ASTM F439.
   2. Joints: ASTM D2846/D2846M, solvent weld with ASTM F493 solvent cement.
   3. Plenum Fire Wrap: 3M Fire Barrier Plenum Wrap 5A+ tested to ASTM E84.
      a. Wrap all piping installed above slab.

2.05 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
   1. PPI TR-4 Pressure Design Basis:
      a. 160 psig at maximum 73 degrees F.
   2. Fittings: Below slab fittings are not allowed.
   3. Joints: Below slab joints are not allowed.

2.06 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Pipe: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
   2. Joints: ASTM B32, alloy Sn95 solder.
   3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
   4. Pipe Sizes Larger than 4 inch: Flanged, Solder or Grooved mechanical couplings.

2.07 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.
   2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.08 STORM DRAINAGE PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
   2. Joints: Heavy duty couplings with neoprene gaskets and stainless steel clamp-and-shield assemblies.
      a. On piping 6 inch above, provide no hub fitting restraints at all changes in direction.

2.09 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.

2.10 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.
   2. Joints: Fusion welded.

2.11 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints:
      a. Gas pressure less than 0.5-psig: Threaded.
      b. Gas pressure greater more than 0.5-psig and less than 5-psig: Welded to ASME B31.1.

2.12 PIPE FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 inch and Under:
   1. Ferrous Pipe: Class 150 malleable iron threaded unions.
   2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Sizes Over 1 inch:
   1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Housing Material: Provide copper.
   3. Bolts and Nuts: Per manufacture recommendations.
   4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. No-Hub Couplings:
   1. Testing: In accordance with ASTM C1277 and CISPI 310.
   2. Gasket Material: Neoprene complying with ASTM C564.
   3. Band Material: Stainless steel.
   4. Eyelet Material: Stainless steel.
   5. Manufacturers:
      a. ANACO-Husky
      b. Clamp-All Corp
      c. Ideal Clamp Products, Inc; Standard: www.idealtridon.com//#sle.
      d. Tyler Pipe: a subsidiary of McWane Inc.
      e. Substitutions: See Section 01 6000 - Product Requirements.

E. Shielded, Heavy Duty No-Hub Couplings:
   1. Testing: In accordance with ASTM C1540 and FM 1680.
   2. Gasket Material: Neoprene complying with ASTM C564.
   3. Band Material: Stainless steel.
   4. Eyelet Material: Stainless steel.
   5. Manufacturers:
      a. ANACO-Husky
      b. Clamp-All Corp
      c. Ideal Clamp Products, Inc; Yellow Shield Heavy Duty: www.idealtridon.com//#sle.
      d. Tyler Pipe: a subsidiary of McWane Inc.
      e. Substitutions: See Section 01 6000 - Product Requirements.

F. No-hub Cast Iron Piping Restraints:
   1. CISPI 301 large diameter no-hub cast iron fittings, 6 inch and larger in size, with supplemental support to minimize the risk of joints separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field devised methods and materials are not permitted.
   2. Manufacturers:
      a. Holdrite No Hub Fitting Restraints.
      b. Substitutions: See Section 01 6000 - Product Requirements.

2.13 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.

B. Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.

2.14 BALL VALVES

A. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, pressfit, threaded or grooved ends with union.

2.15 BUTTERFLY VALVES

A. Construction 2-1/2 inch and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

2.16 PRESSURE REDUCING VALVES

A. 2 inch and Smaller:
1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.
2. Pressure Reducing Pilot-Operator:
a. Operating Range: 5 to 50 psi.
b. Connected into brass or bronze pilot piping and fittings.
c. Fixed flow restrictor, pressure gauges, and isolation valves.

B. 2 inch and Larger:
1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.
2. Pressure Reducing Pilot-Operator:
a. Operating Range: 5 to 50 psi.
b. Connected into brass or bronze pilot piping and fittings.
c. Fixed flow restrictor, strainer, pressure gauges, and isolation valves.

2.17 PRESSURE RELIEF VALVES

A. ANSI Z21.22, AGA certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

2.18 PRESSURE-TEMPERATURE VALVES

A. ANSI Z21.22, AGA certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME BPVC-IV certified and labelled.

2.19 STRAINERS

A. Size 1/2 inch to 3 inch:

1. Class 150, threaded forged bronze Y-pattern body, stainless steel perforated mesh screen with cap, and rated for 150 psi, 250 deg F WOG service.

B. Size 2 inch and Smaller:
   1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
   2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 1-1/2 inch to 4 inch:
   1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line. Provide bentonite “trench plug” that extends at least 5 feet out from the face of the building’s exterior.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
   1. Clearance: 12 incheseach side of pipe.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.03 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice but not before completing the following.
   1. Testing and inspecting underground utilities.
   2. Removing trash and debris.

B. Trench backfill from 6” below pipe to 12” above shall be bank sand.

C. Place and compact bedding course on trench bottoms. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

D. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil.

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill of bed sand or subbase material in 6 inch lifts, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

3.04 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

G. Install valves with stems upright or horizontal, not inverted. See Section 22 0523.

H. Install water piping to ASME B31.9.

I. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

J. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

K. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   3. Place hangers within 12 inches of each horizontal elbow.
   4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

L. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

M. Fire wrap all plastic pipiCPVC piping installed in return air plenums.

3.05 APPLICATION

A. Use grooved mechanical couplings and fasteners only in accessible locations.

B. Install unions downstream of valves and at equipment or apparatus connections.

C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

D. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

E. Install globe valves for throttling, bypass, or manual flow control services.

F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.

G. Provide spring-loaded check valves on discharge of water pumps.

3.06 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8 inch per foot slope.

3.07 FIELD TESTS AND INSPECTIONS

A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.

B. Domestic Water Systems:
   1. Perform hydrostatic testing for leakage prior to system disinfection.
   2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
   3. General:
      a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.

C. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.08 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed, and clean.

B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.09 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, and sand strainer.

3.10 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe Size: 1/2 inch to 1-1/4 inch:
         1) Maximum Hanger Spacing: 6.5 ft.
         2) Hanger Rod Diameter: 3/8 inches.
      b. Pipe Size: 1-1/2 inch to 2 inch:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 3/8 inch.
      c. Pipe Size: 2-1/2 inch to 3 inch:
         1) Maximum Hanger Spacing: 10 ft.
         2) Hanger Rod Diameter: 1/2 inch.

d. Pipe Size: 4 inch to 6 inch:
   1) Maximum Hanger Spacing: 10 ft.
   2) Hanger Rod Diameter: 5/8 inch.
e. Pipe Size: 8 inch to 12 inch:
   1) Maximum hanger spacing: 14 ft.
   2) Hanger Rod Diameter: 7/8 inch.
f. Pipe Size: 14 inch and Over:
   1) Maximum Hanger Spacing: 20 ft.
   2) Hanger Rod Diameter: 1 inch.

2. Plastic Piping:
   a. All Sizes:
      1) Maximum Hanger Spacing: 6 ft.
      2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION

SECTION 22 1006
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Drains.
B. Cleanouts.
C. Hose bibbs.
D. Washing machine boxes and valves.
E. Refrigerator valve and recessed box.
F. Backflow preventers.
G. Double check valve assemblies.
H. Water hammer arrestors.
I. Sanitary waste interceptors.
J. Floor drain trap seals.
K. Electronic trap-seal primers.

1.02 REFERENCE STANDARDS

A. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2022.
B. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2021.
C. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies 2021.
D. ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies 2021.
E. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.
F. NSF 372 - Drinking Water System Components - Lead Content 2022.
G. PDI-WH 201 - Water Hammer Arresters 2017.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
D. Certificates: Certify that grease interceptors meet or exceed specified requirements.
E. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
2. Josam Company; : www.josam.com/#sle.
3. MIFAB, Inc; : www.mifab.com/#sle.
4. Zurn Industries, LLC; : www.zurn.com/#sle.

B. Roof Drains:
1. Assembly: ASME A112.6.4.
2. Body: Lacquered cast iron with sump.
3. Strainer: Removable polyethylene dome with vandal proof screws.
4. Accessories: Coordinate with roofing type, see Section :
   a. Membrane flange and membrane clamp with integral gravel stop.
   b. Adjustable under deck clamp.
   c. Roof sump receiver.
   d. Waterproofing flange.
   e. Adjustable extension sleeve for roof insulation.
   f. O-ring seal between male and female connection pipes.
5. Manufacturers:
   a. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
   b. MIFAB, Inc; : www.mifab.com/#sle.
   c. Zurn Industries, LLC; Z100F: www.zurn.com/#sle.

C. Parapet Drains:
1. Lacquered cast iron body with aluminum flashing clamp collar and epoxy coated sloping grate.

D. Floor Drains:
1. Manufacturers:
   a. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
   b. MIFAB, Inc; FS1100-C Series: www.mifab.com/#sle.
   c. Zurn Industries, LLC; Z415-BZ1: www.zurn.com/#sle.

2.03 CLEANOUTS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
2. Josam Company; : www.josam.com/#sle.
3. MIFAB, Inc; C1100-R: www.mifab.com/#sle.
4. Zurn Industries, LLC; : www.zurn.com/#sle.

2.04 HOSE BIBBS

A. Manufacturers:
1. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
2. Watts Regulator Company; : www.wattsregulator.com/#sle.
3. Zurn Industries, LLC; : www.zurn.com/#sle.

2.05 WASHING MACHINE BOXES AND VALVES

A. Box Manufacturers:
1. IPS Corporation/Water-Tite; : www.ipscorp.com/#sle.
2. Oatey Supply Chain Services, Inc; : www.oatey.com/#sle.

B. Valve Manufacturers:
1. IPS Corporation/Water-Tite; : www.ipscorp.com/#sle.
2. Zurn Industries, LLC; : www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass long shank valves with wheel handles, socket for 2 inch waste, slip in finishing cover.

2.06 REFRIGERATOR VALVE AND RECESSED BOX

A. Box Manufacturers:
   1. IPS Corporation/Water-Tite; : www.ipscorp.com/#sle.
   2. Oatey Supply Chain Services, Inc; : www.oatey.com/#sle.

B. Valve Manufacturers:
   1. IPS Corporation/Water-Tite; : www.ipscorp.com/#sle.
   2. Zurn Industries, LLC; : www.zurn.com/#sle.

C. Description: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.07 BACKFLOW PREVENTERS

A. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
   2. Size: inch assembly with threaded gate valves.

B. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013 and NSF 61 compliant reinforced-nylon body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, integral male test fittings, and non-threaded vent outlet.
   2. Size: 3/4 to 2 inch assembly with threaded gate valves.

C. Reduced Pressure Backflow Preventer Assembly:
   1. ASSE 1013 and NSF 61 compliant stainless steel body assembly with corrosion resistant internal parts, stainless steel springs, diaphragm type differential pressure relief valve located between check valves, third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.
   2. Configured to protect against backsiphonage and backpressure into potable water supply.
   3. Size: 2-1/2 to 10 inch assembly with flanged OS&Y gate valves.

2.08 DOUBLE CHECK-VALVE ASSEMBLIES

A. Double Check Valve Assembly:
   1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
   2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

B. Double Check Valve Assembly:
   1. ASSE 1015 and NSF 61 compliant cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
   2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

2.09 WATER HAMMER ARRESTORS

A. Manufacturers:
   1. Jay R. Smith Manufacturing Company; : www.jrsmith.com/#sle.
   2. Watts Regulator Company, a part of Watts Water Technologies; : www.wattsregulator.com/#sle.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.10 SANITARY WASTE INTERCEPTORS

A. Manufacturers:
   1. Park.

B. Grease Interceptors:
   1. Construction:
      a. Material: Precast concrete complying with ASTM C 913.
      b. Rough-in: On floor.
      c. Cover: Steel, epoxy coated, non-skid with gasket, securing handle, and enzyme injection port, recessed for floor finish.

2.11 FLOOR DRAIN TRAP SEALS

A. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

2.12 ELECTRONIC TRAP-SEAL PRIMERS

A. Description: Enclosed electronic trap seal primer system with timer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Install floor cleanouts at elevation to accommodate finished floor.

E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

F. Pipe relief from backflow preventer to nearest drain.

G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to washing machine outlets or water closets.

END OF SECTION

SECTION 22 1123
DOMESTIC WATER PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

1.02 REFERENCE STANDARDS

A. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.
   2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

C. Shop Drawings: Include dimensions and performance data.

D. Test Reports: Plumbing fixture operational tests.

E. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 PRODUCTS

2.01 CIRCULATORS

A. Manufacturers:
   1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a Brand of Xylem, Inc: www.xylem.com/#sle.
   3. Grundfos Pumps Corporation; MAGNA 3: www.grundfos.com/#sle.

B. Casing: Bronze with bronze cast impeller, and stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E. Pipe-End Connection: Union connection.

F. Maximum Discharge Pressure: 145 psi.

G. Motor: 1,750 rpm, ECM duty with flexible coupling.

H. Service Temperature Range: Minus 30 to 250 degrees F.

I. Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products with related fittings, and accessories according to manufacturer instructions.

B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).

C. Ensure that small pressure gauges are installed on both upstream and downstream ends.

D. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

SECTION 22 1323
SANITARY WASTE INTERCEPTORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Grease interceptors.

1.02 SUBMITTALS

A. Shop Drawings: For each type and size of precast-concrete interceptor indicated.
   1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

PART 2 PRODUCTS

2.01 GREASE INTERCEPTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Park.

B. Grease Interceptors: Precast concrete complying with ASTM C 913.
   1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
   2. Structural Design Loads:
      a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
   3. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
   4. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover.
      a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
      b. Gray Iron: ASTM A 48, Class 35, unless otherwise indicated.
      c. Include indented top design with lettering cast into cover, using wording equivalent to " GREASE INTERCEPTOR."

C. Capacities and Characteristics: (Refer to drawing schedule)

2.02 NEUTRALIZATION TANKS

A. Concrete Neutralization Tanks:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Park Labtank

B. Description: Concrete reinforced neutralizing tank.

C. Concrete: Class I/II concrete with design strength of 4500 PSI at 28 days. Unit is of monolithic construction at floor and first stage of wall with sectional riser to required depth.
   1. Exterior of tank to be lined with bitumastic vapor barrier.
   2. Interior of tank (walls and bottom) shall be lined with H.D. Polyethylene 3/16” thick.
   3. Extension rings shall be concrete and shall be coated with acid resistant epoxy.

D. Reinforcement: Grade 60 reinforced with steel rebar confirming to ASTM A615 on required centers or equal.

E. D.I. Castings: Manhole frames, covers or grates are manufactured of ductile iron conforming to ASTM A536, AASHTO M306 & AASHTO M105 Standards. Manhole shall be nominal 24” diameter and be traffic duty.

F. Neutralizing Fill: Fill to consist of chemical rock of 1” to 3” diameter with calcium carbonate equivalent in excess of 92%.

G. Additional Requirements:
   1. All non-wetted interior surfaces of tank to be coated with acid resistant epoxy.
   2. Refer to drawing schedule and details for additional requirements.

PART 3 EXECUTION

3.01 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. 6 inches beneath bottom of concrete slabs-on-grade.
      e. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.02 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.03 INSTALLATION

A. Install precast-concrete interceptors according to ASTM C 891. Set level and plumb.

B. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.

C. Set tops of manhole frames and covers flush with finished surface in pavements.

D. Set tops of grating frames and grates flush with finished surface.

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.05 IDENTIFICATION

A. Identification materials and installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
   1. Use warning tapes or detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

END OF SECTION

SECTION 22 1500
GENERAL-SERVICE COMPRESSED-AIR SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Reciprocating air compressors.

B. System filters.

C. Pipe and fittings.

D. Unions and couplings.

E. Pressure reducing stations.

F. Air outlets.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 22 0523 - General-Duty Valves for Plumbing Piping.

C. Section 22 0548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

1.03 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.

C. ASME B31.1 - Power Piping 2022.

D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.

E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate piping system schematic with electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Indicate manufacturer's installation instructions, hoisting and setting requirements, starting procedures.

E. Operation Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.

F. Maintenance Data: Submit for air compressor, air receiver, and accessories, aftercooler, refrigerated air dryer, and pressure reducing station.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Compressor Oil: One container, quart size.

1.05 QUALITY ASSURANCE

A. Pressure Vessels: Comply with applicable code for installation of pressure vessels.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept air compressors, refrigerated air dryer on site in factory-fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for reciprocating air compressors.

PART 2 PRODUCTS

2.01 RECIPROCATING AIR COMPRESSORS

A. Manufacturers:
   1. Atlas Copco USA: www.atlascopco.com/#sle.
   2. Ingersoll Rand, Inc: www.ingersollrandproducts.com/#sle.
   3. uincy Compressor, LLC: quincycompressor.com/#sle.

B. Type: Duplex air compressor system with fixed belt-driven mechanism.

C. Electrically-driven, air-cooled compressor unit; factory assembled on surface-mount tank with heat exchangers, air intake filters, gauges, sight glasses, vibration isolators, thermostats, safeties, differential pressure oil pump, thermal overload protections, oil separator, moisture separator with drain trap, oil charging valve, and compressor bearings with ABMA STD 9, L10 life expectancy at 100,000 hours.

D. Receiver Accumulator Tank: 80 gal, mount compressor on horizontal aligned tank.

E. Enclosure: Sound masking enclosure capable of reducing equipment generated noise down to 50 percent of generated loudness.

F. Controls:
   1. Indicators:
      a. Air temperature.
      b. Oil temperature.
      c. Hour meter.
      d. Air discharge pressure.
      e. Sump pressure.
      f. Air intake filter loading.
      g. Anti-recycle timer.
      h. Phase loss/reversal monitor.
   2. Pushbutton or Handswitch: Start/stop and load/unload functions.

G. Electrical:
   1. 7.5 hp at 460-VAC, 50 to 60 hz, TEFC motor, wye-delta starter controlled.
   2. Factory mount disconnect switch with terminal box with each circuit identified and spare spare to accommodate field-installed components. Ground each component to base of assembly.

2.02 SYSTEM FILTERS

A. Cartridge Number 1: Coalescing.

B. Location: Downstream of air compressor.

C. Flow Capacity: Match compressor rate.

2.03 PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Grade B, Type E, Schedule 40 black.
   1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
   2. Joints: Threaded or welded to ASME B31.1.

2.04 UNIONS AND COUPLINGS

A. Unions:
   1. Ferrous Pipe: 150 psi malleable iron threaded unions.

B. Flexible Connector: Neoprene with brass threaded connectors.

2.05 PRESSURE REDUCING STATIONS

A. Pressure Reducing Station: Consisting of automatic reducing valve and bypass and low pressure side relief valve and gauge. Provide oil separator where indicated.

B. Valve Capacity: Reduce pressure from 200 psi to 30 psi, adjustable upwards from reduced pressure.

2.06 AIR OUTLETS

A. uick Connector: 3/8 inch brass, snap-on connector with self closing valve, Style A.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install compressor unit on concrete housekeeping pad. See Section 03 3000.

C. Install compressor unit on vibration isolators. Level and bolt in place. See Section 22 0548.

D. Make air cock and drain connection on horizontal casing.

E. Install line size gate valve and check valve on compressor discharge. See Section 22 0523.

F. Install replaceable cartridge type filter silencer of adequate capacity for each compressor.

G. Connect condensate drains to nearest floor drain.

H. Install valved drip connections at low points of piping system. See Section 22 0523.

I. Install takeoffs to outlets from top of main, with shut off valve after takeoff. Slope takeoff piping to outlets.

J. Install compressed air couplings, female quick connectors, and pressure gauges where outlets are indicated.

K. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial electric water heaters.

B. Domestic hot water boilers.

C. Domestic hot water storage tanks.

D. Water filters.

E. Water softeners.

F. Point-of-use water filters.

G. In-line circulator pumps.

1.02 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data:
   1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
   2. Indicate pump type, capacity, power requirements.
   3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
   4. Provide electrical characteristics and connection requirements.

C. Shop Drawings:
   1. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

D. Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Certifications:
   1. Water Heaters: NSF approved.

B. Identification: Provide pumps with manufacturer's name, model number, and rating/capacity identified by permanently attached label.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide five year manufacturer warranty for domestic water heaters.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Commercial Electric Water Heaters:
   1. Type: Factory-assembled and wired, electric, vertical storage.
   2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
   3. Performance: Refer to drawing schedules.
   4. Electrical Characteristics: Refer to drawing schedules.
   5. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.
   6. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
   7. Accessories:
      a. Water Connections: Brass.
      b. Drain valve.
      c. Anode: Magnesium.
      d. Temperature and Pressure Relief Valve: ASME labeled.
   8. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

2.02 DOMESTIC HOT WATER BOILERS

A. Manufacturers:
   1. Camus Hydronics
   2. Raypak

B. General: The DHW boiler shall be design certified by UL and shall meet the requirements of ANSI Z21.10.3 and CSA 4.3. The boiler shall bear the ASME “H” stamp and shall be national board listed where required.

C. Performance Requirements:
   1. Boiler shall operate up to 93.0% steady state efficiency.
   2. Heat exchanger shall be a fully condensing counter-flow water tube design with stainless steel construction and all welded design with constant allowable system return temperatures of 40F.
   3. Fine tuned combustion premix providing homogeneous air and gas combustion mix to a radial burner incorporating a knitted stainless steel wrap ensuring stable light off and efficient clean combustion.
   4. 5:1 gas input turn down ratio with sustained efficient combustion characteristics throughout entire modulating range.
   5. Factory mounted integral pump, with pre and post purge timing.
   6. Cascade capable integrated control system allowing up to 8 units in lead-lag configuration.
   7. Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.
   8. The boiler is fully factory fire tested to obtain optimum combustion characteristics and to establish certified gas input rates.
   9. System safety and operating devices and controls are fully configured, calibrated and factory tested.
   10. The boiler shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard.
   11. Stainless steel outer jacket construction with easily removed outer panels for ease of service.

D. Heat Exchanger: The heat exchanger shall be inspected and tested to A.S.M.E. Section IV requirements. The A.S.M.E. Section IV seal of approval will not be provided as standard for jurisdictions not requiring the A.S.M.E Section IV seal of approval. The heat exchanger shall be a counter-flow water tube design with multi-pass stainless steel all welded construction heat exchanger with maximum working pressure of 160 PSI (1100 kPa). The heat exchanger design shall be capable of 40°F constant system return temperatures to enable fully condensing operation. Provide pressure relief of valve.

E. Combustion Chamber: The combustion chamber shall be an all welded stainless steel construction which shall be sealed and completely enclosed, independent of the outer jacket assembly. The Stainless Steel combustion chamber shall be designed to drain condensation to the bottom of the heat exchanger assembly. A condensate collection box shall be employed to trap and neutralize flue product condensate. A window view port shall be provided for visual inspection of the boiler combustion during firing.

F. Gas Train: The gas train shall consist of a pressure regulating electro-hydraulic proportional air/gas main gas actuator providing a slow opening, fast closing automatic gas valve safety shutoff and gas pressure regulator. Optional high and/or low gas pressure switch is available. Models DM 200 – DM 800 operate with a 5:1 turndown ratio.

G. Burner: The burner shall be a premix design and constructed of high temperature Stainless Steel with metal fiber outer covering to provide modulating firing rates. The burner shall provide equal distribution of heat through the entire heat exchanger. A window view port shall be provided for visual inspection of the boiler during firing.

H. Controls: Standard controls include a SOLA electronic proportional integrated combination ignition limit/operator control accurate to 10F (0.50C) having a pulse width modulation signal output for modulating fan speeds. Controls are lead lag “Cascade” ready for control of up to eight boilers c/w Indoor outdoor reset and lead lag control. Control shall be equipped and ready with 4-20mA remote set point or modulating control, capable with 0-10 VDC remote set point or modulating control. Control is BMS Modbus RTU protocol ready and capable of other alternate protocol conversions with additional optional gateway protocol converter. Control shall be supplied with a mounted multi-line user configurable display which shall also provide for control system configuration and set up, readouts of boiler target, differential and inlet/outlet temperatures as well as accumulated runtime, enunciator diagnostics, and firing rates. The display shall be accessed through a 5-way touchpad high resolution LCD control with shortcut key access with user and installer protected parameters. The boiler safety control string shall be furnished with controls for optional low gas pressure, optional high gas pressure, blocked flue, high limit, stack limit and flow switch. A current transformer is supplied with all wall hung models to perform flow switch functionality. A paddle style flow switch shall be provided loose on floor mount models. Additional control safeties shall include flame rectification, fan speed, and high limit.

I. Venting: Provide approporate venting and intake flue system including all required accessories and components.

J. External Jacket and Fasteners: The external jacket shall be of 430 stainless steel mirror finish panels and powder coated steel assembled utilizing interference fit locks and minimal non-strip self tap screws for ease of removal and access to the heat exchanger and combustion air / gas control.

2.03 DOMESTIC HOT WATER STORAGE TANKS

A. Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.

B. Tank Interior: Glassed Lining

C. Tank Exterior: Baked Enamel Steel Jacket

D. Insulation: 2 inch thick, non-cfc foam on respective top and tank sides.

E. Openings: Up to 3 inches, NPT.

2.04 WATER FILTERS

A. Commercial:
   1. Filter Media: Activated carbon.
   2. Glassfiber reinforced plastic tank with valve, 30 gpm.
   3. Provide capped backwash, carbon refill, and sediment removal access.
   4. Potable Water Service: NSF 61 certified.

2.05 WATER SOFTENERS

A. Salt-Based Ion-Exchange Water Softener:
   1. Manufacturers:
      a. Culligan International Company: www.culligan.com/#sle.
      b. US Water Systems, Inc: www.uswatersystems.com//#sle.
      c. Substitutions: See Section 01 6000 - Product Requirements.
   2. Type: Separate ion exchange and feed tanks.
   3. Tank Materials: Epoxy lined steel ion exchange with one-piece resin for feed.

2.06 POINT-OF-USE WATER FILTERS

A. Point-of-Use Application: Provide for ice makers and Drinking fountains.

B. Type: Disposable, side positioned, line or tap installed cartridge, canister, or showerhead filter.

C. Construction: Polymer based material housing with built-in female threaded connections, and internal specific or composite filtering media such as activated carbon, sand, gravel, calcite, limestone, or other mineral media suitable to reduce intended contaminants.

D. Internal Filter Media: Chemical-free, pH-resilient materials proven to reduce bacteria, chlorine, odors, sediment, and trace metals down to the 0.2 micron particle size.

E. Maximum Service Requirements: 100 psi and 130 degrees F.

2.07 IN-LINE CIRCULATOR PUMPS

A. Manufacturers:
   1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/#sle.
   2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.

B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.

C. Impeller: Bronze.

D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.

E. Seal: Carbon rotating against a stationary ceramic seat.

F. Drive: Flexible coupling.

2.08 ELECTRICAL WORK

A. Provide electrical motor driven equipment specified complete with motors, motor starters, controls, and wiring.

B. Electrical characteristics to be as specified or indicated.

C. Furnish motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.

B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.

C. Domestic Water Storage Tanks:
   1. Provide steel pipe support, independent of building structural framing members.
   2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

D. Pumps:
   1. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
   2. Provide electrical interlocking from cooling condensate pump safety switch to associated HVAC unit(s) furnished under other Sections.

E. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

END OF SECTION

SECTION 22 4200
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

1.02 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
   3. Vitreous-China Fixtures: ASME A112.19.2M.
   4. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
   5. Water-Closet, Flushometer Tank Trim: ASSE 1037.

PART 2 PRODUCTS

2.01 PLUMBING FIXTURES AND TRIM

A. Refer to fixture schedule on drawings for fixture and trim requirements. Manufacturers shall be limited to those listed on schedule.

2.02 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers, provide on all ADA fixtures:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Engineered Brass Co.
      b. McGuire Manufacturing Co., Inc.
      c. TRUEBRO, Inc.
      d. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
   2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.03 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Josam Company.
   2. Smith, Jay R. Mfg. Co.
   3. Tyler Pipe; Wade Div.
   4. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
   5. Zurn Plumbing Products Group; Specification Drainage Operation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

N. Install toilet seats on water closets.

O. Install trap-seal liquid in dry urinals.

P. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

R. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

S. Install shower flow-control fittings with specified maximum flow rates in shower arms.

T. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

U. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

V. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

W. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Replace washers and seals of leaking and dripping faucets and stops.

C. Install fresh batteries in sensor-operated mechanisms.

3.06 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 0120
MECHANICAL SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Contractor shall submit for acceptance to the Architect shop drawings specified for the equipment indicated in these specifications. The shop drawings shall include the following minimum information:
   1. The equipment manufacturer's name and address
   2. Catalog designation or model number
   3. Rough-in data & dimensions
   4. Performance curves and rated capacities & operational characteristics.
   5. Equipment specific wiring diagrams.
   6. Electrical characteristics.
   7. Warranty information.

B. All submittals shall be electronic in PDF format, hard copies will not be accepted.

C. The Contractor shall thoroughly review each item for compliance with these Specifications making any necessary corrections prior to submittal. Each shop drawing set shall be stamped, signed, and dated indicating Contractor review.
   1. If the Contractor fails to properly review shop drawings, the Contractor shall reimburse the Engineer for all additional reviews on a time and material basis.

D. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with "Compliance". Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. "C" for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. "D" for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. "A" for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. "N/A" for Not Applicable: By noting the term "not applicable" or "N/A" in the margin, it shall be understood that the specified item is not applicable to the project.

E. Provide samples of materials or equipment proposed to be furnished, if requested. Samples shall become the property of the Architect/Engineer and will be returned only when accompanied by a written request to do so.

F. None of the items listed shall be purchased, delivered to the site, or installed, until the item is reviewed. No substitution will be permitted after review except where such substitution is considered by the Architect to be in the best interest of the Owner.

G. The Engineer will review all Shop Drawings submitted.

H. Approval Stamp: This review is to verify general conformance with the design concept of the Project and substantial compliance with the information provided in the Contract Documents. This review does not in any way relieve the Contractor or their suppliers of their responsibility to provide all materials and equipment as specified, in quantities, quality and dimensions required. Submittals will be reviewed with the following actions:
   1. “Reviewed” indicates that the Submittal appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation. Shop drawings that are returned "Reviewed" or "Furnished as Corrected" shall not be resubmitted back to the engineer and if submitted will not be reviewed.
   2. “Furnished as Corrected” indicates that the Submittal, after noted corrections are made, appears to conform to the design concept of the Work and that the Contractor, at their discretion, may proceed with fabrication and/or procurement and installation, if the corrections are accepted by the Contractor without any increase in Contract Sum or Time. If the corrections are accepted by the contractor, shop drawings that are returned "Furnished as Corrected" shall not be resubmitted back to the engineer and if submitted will not be reviewed.
   3. “Revised and Resubmit” indicates that the noted revisions are such that a corrected copy of the Submittal is required for review to confirm that the noted revisions have been understood and made. The Contractor, at their discretion, may proceed with fabrication and/or procurement and installation after submitting a corrected copy and verifying with the reviewer that the corrected copy is acceptable, if the corrections are accepted by the Contractor without an increase in the Contract Sum or Time.
   4. “Rejected” indicates that the Submittal does not appear to conform to the specifications, a resubmission is required, and fabrication or procurement is not authorized.

I. If the Engineer rejects (Revised and Resubmit or Rejected) the same section two times the engineer shall be compensated for additional reviews. Any subsequent submittal will require the inclusion of a check made out to the engineer in the amount of 500.00. Contractor is responsible for all delays caused by the resubmittal process.

J. Should the contractor fail to comply with any of the requirements of the preceding sub-paragraphs; then the right is reserved by the Architect to select any or all items in the material schedule, with that selection to be final and binding upon the contractor. The materials selected or reviewed, as the case may be, by the Architect, shall be used in the work at no additional cost to the Owner.

K. Where a contractor chooses to use any reviewed material or item of equipment, other than the one shown on the drawings, or specified in detail, he shall be responsible for coordinating any necessary changes in other work and shall bear the cost of such changes.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 MANUALS

A. In addition to catalog data and shop drawings submitted for review, this contractor shall furnish Systems Manuals (O&M's):
   1. The Contractor Shall provide an electronic copy in PDF format. The PDF shall contain:
      a. Approved Shop Drawings of all major mechanical components.
      b. Parts lists for the same components.

c. Manufacturer's operating, maintenance, and cleaning instructions.
d. List of materials recommended for maintenance.
e. Factory startup reports.
f. Valve tag list.
g. Name and address of authorized service organization and parts depot.
h. Chemical Treatment Analysis Reports for heating & cooling systems.
i. Radiographic Testing Reports of welded pipe with picture of weld & location plan showing physical location of where test was performed.
j. A description of how the components of a given HVAC system interact within the large system. For example, circulating pumps, boilers, unit heaters are part of the "heating system".
k. A description of normal operating conditions for the system and its components.
l. A description of common symptoms of a malfunctioning system and likely causes.
m. Warranty letter from the automatic temperature controls contractor indicating the warranty period for their portion of the work.
n. Signed owner instruction forms for all items specified as requiring owners' instruction.

2. The Systems manual shall have an electronic index and be broken up by individual systems such as "heating", "shop exhaust", "kitchen ventilation and exhaust", "chilled water", "administration ventilation".
3. Include at the front of the manual a complete listing of the Architect, Engineer and contractors and sub-contractors used on the project. Listing shall include names, addresses and phone numbers for each.
4. All major pieces of equipment shall be referenced with the equipment supplier's name, address and phone number shall be provided.
5. Where indicated in the Specifications, the Contractor shall provide the services of a factory trained representative to instruct the Owner's authorized personnel in the operation, control, and maintenance of equipment.

B. Operations and Maintenance Manuals shall be submitted to the Engineer for approval prior to delivery to the Architect.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION – NOT USED

END OF SECTION

SECTION 23 0150
MECHANICAL MATERIALS & METHODS

PART 1 GENERAL

1.01 APPLICABILITY

A. This section covers basic materials and methods and applies to and forms a part of each of the sections of Division 23.

B. This work shall be in accordance with this and other applicable sections and/or provisions of these specifications and with the applicable drawings.

1.02 COORDINATION OF OPENINGS

A. This contractor shall coordinate all openings required for new piping, ductwork, equipment, controls, etc. through any structural slabs, beams, or walls. Contractor shall request a copy of the precast concrete shop drawings and verify locations and sizes of all openings required.

B. All costs associated with structural field changes or redesigns of the building systems due to lack of field coordination shall be responsibility of this contractor.

1.03 MATERIALS & MANUFACTURERS

A. All materials and equipment shall be new, free of defects, installed in accordance with manufacturer's current published recommendations in a neat manner and in accordance with standard practice of the industry.

B. Certain materials and/or equipment in this specification are specified by manufacturer and catalog numbers. The design was based on the specified equipment and establishes a degree of quality, performance, physical configuration, etc. If the contractor should elect to use equipment other than the equipment used as a basis for design but listed as "acceptable" in the specifications, he shall be responsible for space requirements, configuration, performance, and changes in bases, supports, vibration isolators, structural members, openings in structure and other apparatus that may be affected by its use.

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. Piping is to be installed as shown on the drawings as much as practical. When a pipe size is not indicated, the subcontractor shall request the pipe size from the Architect through the Mechanical Contractor.

B. Provide sufficient swing joints, expansion loops, and/or devices necessary and install so as to permit free expansion and contraction of piping without causing undue stresses. Make all changes in direction with fittings. Support piping independently at all equipment so that its weight shall not be supported by the equipment.

C. Install piping without springing or forcing and clear all windows, doors, and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted.

D. All pipes shall be reamed to full pipe diameter before joining.

E. Install vertical risers plumb and straight, horizontal lines parallel with walls and partitions. Conceal piping above ceilings and within furring and/or walls (finished construction).

F. Provide shut-off valves and unions suitably located to isolate each item of equipment, branch circuit or section of piping.

G. Provide solid head plugs on any crosses, tees, etc., located in the piping around the boilers.

H. Provide drain valves at all low points of each system to enable complete drainage. Drain shall consist of a 3/4” ball valve with hose end.

I. Provide a manual air vent consisting of 1/2" ball valve with hose end installed on a "T" at all high points of each system to enable complete venting.

J. All piping shall be adequately supported from the building structure with adjustable hangers to maintain uniform grading where required and to prevent sagging or pocketing.

K. Provide supports between piping and building structure where necessary to prevent swaying.

L. The use of wire or perforated metal to support pipe will not be permitted.

2.02 SUPPORTING STEEL

A. Provide structural steel framework for supporting mechanical equipment as required.

B. All steel work shall be in conformance with the requirements of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Material shall conform to ASTM A36.

PART 3 EXECUTION

3.01 PROTECTION, DELIVERY AND STORAGE OF MATERIALS

A. Make provisions for the delivery and storage of materials and make the required arrangements with other contractors for the introduction into the building of equipment too large to pass through finished openings.

B. Protect materials and equipment stored on site from weather and moisture by maintaining factory covers and/or suitable weather-proof coverings. For extended outdoor storage, motors shall be removed from equipment and stored separately.

C. The open ends of all piping and ductwork shall be covered whenever that system is not being worked on, i.e., end of the workday, completion of a section, etc. Covering shall keep dust, garbage, vermin, and other foreign objects out of the piping or ductwork when the contractor is not on the jobsite.

3.02 CUTTING AND REPAIRING

A. All holes and penetrations required for the installation of the mechanical equipment shall be by the mechanical contractor. This shall include all piping, ductwork, and any other penetration through the wall, floor, or roof.

B. Cutting construction shall be done only with the written permission of the Architect. Cutting shall be done carefully and damage to buildings, pipes, wiring, or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved at no additional charge to the Owner. This Contractor shall be responsible for all cutting and patching unless such work has been delegated to the General Contractor.

C. All holes cut into concrete shall be cut by means of power saws or core drills. All unsightly spalls or chips shall be repaired.

D. All openings remaining around duct and pipe penetrations shall be filled, caulked, and painted to match wall. Code approved fire caulking shall be used for all rated penetrations.

3.03 SEALING FLOOR, CEILINGS AND WALL OPENINGS

A. Where pipes or ducts pass through walls, ceilings, floors, or partitions, (other than those through fire rated walls or chases) the opening in the construction around the pipe or duct shall not exceed □ inch average clearance on all sides and shall be sealed to prevent the passage of sound and air. Coordinate wall openings to allow insulation thickness to pass through walls if allowed.

B. The material used to seal space between the wall and the pipe/duct shall be non-combustible caulk type, or wrap type, as conditions require. Provide sheet metal angles or flanges as may be required to contain the stopping material. Use of expanding foam will be allowed if surfaces are cleaned of an excess material and all edges are trimmed smooth. Penetrations through exterior walls shall be sealed weather tight.

C. Special attention shall be given to penetrations of mechanical room walls. Fill gaps around entire exterior area of the pipes or ducts with sound insulation (batt or mineral wool) to within ½" of the wall surface. Use silicone caulking to finish filling the opening smooth with the wall surface or provide sheet metal angles. All sealer shall meet flame spread 25 and smoke developed less than 50.

D. Where pipes or ducts pass through fire-rated walls, ceilings, floors, vertical service shafts walls, or partitions, the opening in the construction around the pipe or duct shall be fire-stopped to prevent the passage of flame and smoke. All assemblies shall be UL or ASTM listed to provide a fire rating equal to that of the construction being penetrated. For the firestop applications that exist for which no UL tested system is available through a manufacturer, an engineering judgment derived from similar UL system designs or other tests shall be submitted from the manufacturer to the local authorities having jurisdiction for their review and approval prior to installation. Individuals installing the firestopping shall be experienced and certified as required by the manufacturer whose product is being applied. Refer to firestopping specification section for more information.

E. Manufacturer's assembly drawings shall be provided in O & M Manuals for each type of penetration. Printed metal or plastic labels shall be permanently applied on the structure within 6" of the edge of the firestop system. Metal labels shall be applied with mechanical fasteners & plastic labels shall be the self-adhering type with adhesive capable of permanently bonding labels to the surfaces on which the labels are placed. The information required on the label include UL/ASTM assembly number, date of installation, fire stopping material manufacture name, Contractor's name, address & phone number & the installer's name.

F. Duct coverings shall not extend through walls or floors required to be fire-stopped or have a fire resistance rating. Insulation shall be taped or sealed to the walls to eliminate sweating at any fire and/or smoke dampers.

G. Acceptable manufacturers shall be Hilti, 3M Brand, or a prior approved product.

3.04 CLEANING AND PAINTING

A. Clear away all debris, surplus materials, etc., resulting from work or operations, leaving the job and equipment furnished under this contract in a clean condition.

B. All exposed ductwork visible behind grilles, registers or air terminals shall be painted flat black.

C. All equipment being furnished with finished paint coat shall be examined upon job completion for scratches and other surface damage. All finished surfaces where necessary shall be touched up with touch-up paint of color to match the factory finish.

D. Paint all exposed bare pipe exterior of the building. Bare pipe shall be painted one coat of No. 7769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Final coat shall be of a color selected by the architect.

E. Paint all exposed iron and steel work, pipe hangers, pipe stands, uninsulated tanks, supporting steel for equipment and exposed bare pipe in mechanical areas. Iron and steel work and bare pipe shall be painted one coat of No. 4769402 damp-proof red primer as manufactured by Rust-Oleum Corporation, or equal, and one coat of oil paint. Iron and steel work shall be painted black.

3.05 ASBESTOS FREE BUILDING

A. There shall be no products or building materials used as a temporary or permanent element in the construction of this building, which has in its make-up any form of asbestos. The contractors shall be responsible to monitor shop drawings and product literature to verify the make-up of materials to be used in the building and remind material suppliers that their products must be asbestos free.

B. Notify the Architect immediately of any existing materials which are suspected of containing asbestos. Do not disturb or attempt to remove any asbestos containing material. The Architect will contact the Owner and inform them of the Contractors observations. The Owner will obtain and provide the services of professionals skilled in asbestos removal.

3.06 SALVAGE:

A. All items removed from existing building shall be salvaged in a workmanlike manner.

B. The handling, storage, and disposition of salvage materials shall be as directed by the Architect. Generally, all salvage material shall remain the property of the Owner. Materials and equipment not wanted by Owner shall be removed from the job site and become the property of the contractor.

END OF SECTION

SECTION 23 0513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

1.02 REFERENCE STANDARDS

A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015 (Reaffirmed 2020).

B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators 2017.

C. NEMA MG 1 - Motors and Generators 2021.

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service:
   1. Motors 3/4 HP and Smaller: 115 volts, single phase, 60 Hz.
   2. Motors Larger than 3/4 Horsepower: Three phase, 60 Hz, motor voltage to be coordinated with electrical drawings.

B. Construction:
   1. Open drip-proof type except where specifically noted otherwise.
   2. Design for continuous operation in 104 degrees F environment.
   3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
   4. All motors shall be premium efficiency type.

C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

D. Wiring Terminations:
   1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
   2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.02 APPLICATIONS

A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Motors located in exterior locations: Totally enclosed type.

C. Motors located in outdoors, in wet air streams downstream of sprayed coil dehumidifiers, in draw through cooling towers, and in humidifiers: Totally enclosed weatherproof epoxy-treated type.

D. Motors located in draw through cooling towers: Totally enclosed weatherproof epoxy-sealed type.

2.03 SHAFT GROUNDING

A. All motors over 1 HP on variable frequency drives shall be equipped with shaft grounding system to discharge shaft voltage potential to ground. Motors on variable frequency drives shall be bonded from the motor foot to system ground with high frequency grounding strap consisting on tinned, copper strap with terminations to accommodate the motor foot and system ground.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS

A. Starting Torque: Less than 150 percent of full load torque.

B. Starting Current: Up to seven times full load current.

C. Breakdown Torque: Approximately 200 percent of full load torque.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.06 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.

D. Insulation System: NEMA Class H or better.

E. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

G. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

H. Sound Power Levels: To NEMA MG 1.

I. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

J. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

K. Nominal Power Factor: As indicated at full load and rated voltage when tested in accordance with IEEE 112.

2.07 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Electronically Commutated Motor
   1. Motor to be a DC electronic commutation type motor (ECM) specifically designed for application.
   2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   3. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   4. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pressure gauges and pressure gauge taps.

B. Thermometers and thermometer wells.

C. Static pressure gauges.

1.02 REFERENCE STANDARDS

A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2022.

B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).

C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).

D. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance 2012, with Addendum (2018).

E. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
   1. Case: Steel with brass bourdon tube.
   2. Size: 4-1/2 inch diameter.
   3. Mid-Scale Accuracy: One percent.
   4. Scale: Psi.

2.02 PRESSURE GAUGE TAPPINGS

A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Stem: 3/4 inch NPT brass.

4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

2.06 STATIC PRESSURE GAUGES

A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.

C. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

D. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Extend nipples and siphons to allow clearance from insulation.

E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

F. Install thermometers in air duct systems on flanges.

G. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Globe valves.
B. Ball valves.
C. Butterfly valves.
D. Check valves.
E. Gate valves.
F. Chainwheels.

1.02 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. PTFE: Polytetrafluoroethylene.
G. RS: Rising stem.
H. TFE: Tetrafluoroethylene.
I. WOG: Water, oil, and gas.

1.03 REFERENCE STANDARDS

A. ASME B1.20.1 - Pipe Threads, General Purpose, Inch 2013 (Reaffirmed 2018).
B. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.
E. ASME B31.9 - Building Services Piping 2020.
F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - ualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.
G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984, with Editorial Revision (2019).
I. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings 2015 (Reapproved 2021).
J. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
K. AWWA C606 - Grooved and Shouldered Joints 2022.
L. MSS SP-67 - Butterfly Valves 2022.
M. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends 2011.

N. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.

O. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.

P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer:
   1. Obtain valves for each valve type from single manufacturer.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
   2. Protect valve parts exposed to piped medium against rust and corrosion.
   3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
   4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.
   5. Secure check valves in either the closed position or open position.
   6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:
   1. Maintain valve end protection and protect flanges and specialties from dirt.
      a. Provide temporary inlet and outlet caps.
      b. Maintain caps in place until installation.
   2. Store valves in shipping containers and maintain in place until installation.
      a. Store valves indoors in dry environment.
      b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:
   1. Handle large valves with sling, modified to avoid damage to exposed parts.
   2. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable valve manufacturers are:
   1. NIBCO

2.02 APPLICATIONS

A. See drawings for specific valve locations.

B. Listed pipe sizes shown using nominal pipe sizes (NPS) and nominal diameter (DN).

C. Provide the following valves for the applications if not indicated on drawings:
   1. Throttling (Hydronic): Butterfly, Ball, and Globe.
   2. Isolation (Shutoff): Butterfly, Gate, and Ball.
   3. Swing Check (Pump Outlet):
      a. Size 2 inch and Smaller: Bronze with bronze disc.
      b. Size 2-1/2 inch and Larger: Iron with lever and weight or lever and spring.

4. Dead-End: Butterfly, single-flange (lug) type.

D. Substitutions of valves with higher CWP classes or WSP ratings for same valve types are permitted when specified CWP ratings or WSP classes are not available.

E. Required Valve End Connections for Non-Wafer Types:
   1. Steel Pipe:
      a. Size 2 inch and Smaller: Threaded ends.
      b. Size 2-1/2 inch and Larger: Grooved or flanged ends.
   2. Copper Tube:
      a. Size 2 inch and Smaller: Threaded ends, except solder-joint valve-ends.
      b. Size 2-1/2 inch and Larger: Grooved ends.

F. Chilled Water Valves:
   1. Size 2 inch and Smaller, Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, two piece, stainless steel trim.
      c. Swing Check: Bronze disc, Class 125 .
      d. Globe: Bronze disc, Class 125.
   2. Size 2-1/2 inch and Larger, Iron Valves:
      a. 2-1/2 inch to 4 inch: Flanged ends.
      b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
      c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
      d. Swing Check: Metal seats, Class 125.
      e. Swing Check with Closure Control: 2-1/2 inch to 12 inch, lever and spring, Class 125.
      f. Grooved-End Check: 3 inch to 12 inch, 300 CWP.

G. Condenser Water Valves:
   1. Size 2 inch and Smaller, Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, two piece, stainless steel trim.
      c. Swing Check: Bronze disc, Class 125.
   2. Size 2-1/2 inch and Larger, Iron Valves:
      a. 2-1/2 inch to 4 inch: Flanged ends.
      b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
      c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.
      d. Swing Check: Metal seats, Class 125.
      e. Swing Check with Closure Control, 2-1/2 inch to 12 inch: Lever and spring, Class 125.
      f. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

H. Heating Hot Water Valves:
   1. Size 2 inch and Smaller, Bronze Valves:
      a. Threaded ends.
      b. Ball: Full port, one piece, stainless steel trim.
      c. Swing Check: Bronze disc, Class 125.
   2. Size 2-1/2 inch and Larger, Iron Valves:
      a. 2-1/2 inch to 4 inch: Flanged ends.
      b. Single-Flange Butterfly: 2-1/2 inch to 12 inch, aluminum-bronze disc, EPDM seat, 200 CWP.
      c. Grooved-End Butterfly: 2-1/2 inch to 12 inch, 175 CWP.

d. Swing Check: Metal seats, Class 125.
e. Swing Check: 2-1/2 inch to 12 inch, lever and spring closure control, Class 125.
f. Grooved-End Swing Check: 3 inch to 12 inch, 300 CWP.

2.03 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Actuator Types:
1. Gear Actuator: uarter-turn valves 8 inch and larger.
2. Handwheel: Valves other than quarter-turn types.
3. Hand Lever: uarter-turn valves 6 inch and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator, of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: Provide 2 inch stem extensions and the following features:
1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: Extended neck.
3. Memory Stops: Fully adjustable after insulation is installed.

E. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:
1. Threaded End Valves: ASME B1.20.1.
2. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
3. Pipe Flanges and Flanged Fittings 1/2 inch through 24 inch: ASME B16.5.
4. Solder Joint Connections: ASME B16.18.
5. Press-Connect Connections: ASME
6. Grooved End Connections: AWWA C606.

G. General ASME Compliance:
1. Building Services Piping Valves: ASME B31.9.

2.04 BRONZE, GLOBE VALVES

A. CWP Rating: Class 125: 200 psi:
1. Comply with MSS SP-80, Type 1.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze or PTFE.
5. Packing: Asbestos free.
6. Handwheel: Malleable iron.

2.05 BRONZE, BALL VALVES

A. General:
1. Fabricate from dezincification resistant material.
2. Copper alloys containing more than 15 percent zinc are not permitted.

B. Two Piece, Full Port with Stainless Steel Trim:
1. Comply with MSS SP-110.
2. SWP Rating: 150 psi.
3. CWP Rating: 600 psi.
4. Body: Bronze.
5. End Connections: Pipe press, thread, or solder.

6. Seats: PTFE.
7. Stem: Stainless steel.
8. Ball: Stainless steel, vented.
9. Ends: Threaded, Soldered, or Press.

2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES

A. Lug Style; Bidirectional Dead-End Service without Use of Downstream Flange:
1. Comply with MSS SP-67, Type I.
2. Lug Style, CWP Ratings:
   a. Sizes 2 to 12 inch: 150 psi.
   b. Vacuum Service: Down to 29.9 in-Hg.
3. Body Material: ASTM A536 ductile iron.
4. Stem: One or two-piece stainless steel.
5. Seat: EPDM.
6. Disc: Aluminum Bronze or Stainless steel.

2.07 IRON, GROOVED-END BUTTERFLY VALVES

A. CWP Rating: 300 psi.
1. Comply with MSS SP-67, Type I.
2. Body: Coated ductile iron.
3. Stem: Two-piece stainless steel.
4. Disc: EPDM Encapsulated, ductile iron.
5. Disc Seal: EPDM.

2.08 BRONZE, LIFT CHECK VALVES

A. Class 125:
1. Comply with MSS SP-80, Type 2, Nonmetallic Disc to Metal Seat.
2. CWP Rating: 250 psi.
3. Design: Vertical or horizontal flow.
4. Body: ASTM B61 or ASTM B62 Bronze.
5. Ends: Threaded, Soldered, or Press.
6. Disc (Type 2): NBR or PTFE.

2.09 BRONZE, SWING CHECK VALVES

A. Class 150:
1. Pressure and Temperature Rating: MSS SP-80, Type 3.
2. Design: Y-pattern, horizontal or vertical flow.
3. CWP Rating: 300 psi.
4. Body Design: Y-pattern, horizontal or vertical flow.
5. Body: ASTM B62 bronze.
6. End Connections: Threaded, Soldered, or Press.
7. Disc: Bronze or PTFE.

2.10 IRON, FLANGED END SWING CHECK VALVES

A. Class 125:
1. Comply with MSS SP-71, Type I.
2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
3. Body Design: Clear or full waterway.
4. Body Material: ASTM A126, gray iron with bolted bonnet.
5. Ends: Flanged.
6. Trim: Bronze.
7. Gasket: Asbestos free.

2.11 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Class 125:
   1. Comply with MSS SP-71, Type I.
   2. Sizes 2-1/2 to 12 inch: CWP Rating; 200 psi.
   3. Body Design: Clear or full waterway.
   4. Body Material: ASTM A126, gray iron with bolted bonnet.
   5. Ends: Flanged.
   6. Trim: Bronze.
   7. Gasket: Asbestos free.
   8. Closer Control: Factory installed, exterior lever, and spring or weight.

2.12 IRON, GROOVED-END SWING CHECK VALVES

A. Class 250:
   1. CWP Rating: 250 psi.
   2. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
   3. Seal: EPDM.
   4. Disc: Spring Operated, stainless steel with EPDM.

2.13 IRON, GATE VALVES

A. OS&Y:
   1. Comply with MSS SP-70, Type I.
   2. Class 125:
      a. Sizes 2-1/2 to 12 inch, CWP Rating; 200 psi.
      b. Sizes 14 to 24 inch, CWP Rating; 150 psi.
   3. Body Material: ASTM A126 gray iron with bolted bonnet.
   4. Ends: Flanged.
   5. Trim: Bronze.
   6. Disc: Solid wedge.
   7. Packing and Gasket: Asbestos free.

2.14 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
   1. Where Required: Install in central plant on piping larger than 6 inch when valve is located higher than 12 ft above finished floor.
   2. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   3. Attachment: For connection to ball, butterfly, and plug valve stems.
   4. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
   5. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment components.

1.02 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.

C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping 2023.

D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2022).

F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates 2018.

G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2022).

H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.

I. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.

J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

K. FM (AG) - FM Approval Guide Current Edition.

L. MFMA-4 - Metal Framing Standards Publication 2004.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

N. UL (DIR) - Online Certifications Directory Current Edition.

O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
   2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
   3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
   4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
   5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Prefabricated Trapeze-Framed Metal Strut Systems:
   1. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
   2. Strut Channel or Bracket Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

C. Strut Channels:
   1. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
   2. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

D. Channel Nuts:
   1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

E. Hanger Rods:
   1. Threaded zinc-plated steel unless otherwise indicated.
   2. Minimum Size, Unless Otherwise Indicated or Required:

a. Equipment Supports: 1/2 inch diameter.
b. Piping up to 1 inch: 1/4 inch diameter.
c. Piping larger than 1 inch: 3/8 inch diameter.
d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

F. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
2. Liquid Temperatures Up To 122 degrees F:
a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
b. Support From Below: MSS SP-58 Types 35 through 38.
3. Operating Temperatures from 122 to 446 degrees F:
a. Overhead Support: MSS SP-58 Type 1 or 3 through 12, with appropriate saddle of MSS SP-58 Type 40 for insulated pipe.

G. Roller Chairs:
1. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.
2. Steel Yoke Type: MSS SP-58 type 44, vertically adjustable, nonconductive, and corrosion resistant.
3. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.

H. Pipe Stanchions:
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.

I. Beam Clamps:
1. MSS SP-58 types 19 through 23, 25 or 27 through 30 based on required load.
2. Beam C-Clamp: MSS SP-58 type 23, malleable iron and steel with plain, stainless steel, and zinc finish.
3. Small or Junior Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish. For inverted usage provide manufacturer listed size(s).
4. Wide Mouth Beam Clamp: MSS SP-58 type 19, malleable iron with plain finish.
5. Centerload Beam Clamp with Extension Piece: MSS SP-58 type 30, malleable iron with plain finish.
6. FM (AG) and UL (DIR) Approved Beam Clamp: MSS SP-58 type 19, plain finish,
7. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
8. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.

J. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.

K. U-Bolts:
1. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.

L. Strut Clamps:
   1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.

M. Insulation Clamps:
   1. Two bolt-type clamps designed for installation under insulation.
   2. Material: Carbon steel with epoxy copper or zinc finish.

N. Pipe Hangers:
   1. Split Ring Hangers:
      a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
      b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
      c. Provide hanger rod and nuts of the same type and material for a given pipe run.
      d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
   2. Swivel Ring Hangers, Adjustable:
      a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
      b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
      c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
   3. Clevis Hangers, Adjustable:
      a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
      b. Felt-Lined: MSS SP-58 Type 1, zinc-plated, silicone-free carbon steel.
      c. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.

O. Intermediate Pipe Guides:
   1. Pipe Diameter 6 inch and Smaller: Provide minimum clearance of 0.16 inch.
   2. Pipe Sizes 8 inch: 0.625 inch U-bolt with double nuts providing minimum clearance of 0.28 inch.
   3. Pipe Size 10 inch: 0.75 inch U-bolt.
   4. Pipe Sizes 12 to 16 inch: 0.875 inch U-bolt.
   5. Pipe Sizes 18 to 30 inch: 1 inch U-bolt.
   6. Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.

P. Pipe Alignment Guides: Galvanized steel.
   1. Pipe Sizes 8 inch and Smaller: Spider or sleeve type.
   2. Pipe Sizes 10 inch and Larger: Roller type.

. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

R. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
   1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
   2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
   3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

S. Pipe Shields for Insulated Piping:
   1. General Construction and Requirements:
      a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
      b. Shields Material: UV-resistant polypropylene with glass fill.
      c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.

d. Minimum Service Temperature: Minus 40 degrees F.
e. Maximum Service Temperature: 178 degrees F.
f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

T. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Steel: Use beam-ceiling clamps, beam clamps, machine bolts, or welded threaded studs.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

F. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

G. Secure fasteners according to manufacturer's recommended torque settings.

H. Remove temporary supports.

END OF SECTION

SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting: Identification painting.

1.02 REFERENCE STANDARDS

A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Product Data: Provide manufacturers catalog literature for each product required.

D. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

A. Air Handling Units: Nameplates.

B. Air Terminal Units: Tags.

C. Control Panels: Nameplates.

D. Heat Transfer Equipment: Nameplates.

E. Piping: Pipe markers.

F. Pumps: Nameplates.

G. Tanks: Nameplates.

H. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

A. Letter Color: White.

B. Letter Height: 1/4 inch.

C. Background Color: Black.

D. Plastic: Comply with ASTM D709.

2.03 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual Label.

C. Color: Yellow/Black.

2.05 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   2. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
   3. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
   4. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
   5. Ductwork and Equipment: 2-1/2 inch high letters.

B. Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   1. Color Coding:
      a. Chilled Water Piping: Green
      b. Hot Water Piping: Light Red

C. Underground Plastic Pipe Markers: Bright-colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil, 0.004 inch thick, manufactured for direct burial service.

D. Ammonia Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.

2.07 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Green.
   2. Fire Dampers and Smoke Dampers: Red.
   3. Heating/Cooling Valves: Yellow.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 9123.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.

B. Section 23 0800 - Commissioning of HVAC.

1.02 REFERENCE STANDARDS

A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.

B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Installer ualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to Architect.
   2. Submit to the Commissioning Authority.
   3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   4. Include at least the following in the plan:
      a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      d. Final test report forms to be used.
      e. Expected problems and solutions, etc.
      f. Details of how TOTAL flow will be determined; for example:
         1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
         2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
      g. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least twice a week to the Commissioning Authority.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.

3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Perform total system balance in accordance with one of the following:
1. AABC (NSTSB), AABC National Standards for Total System Balance.

B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.

C. TAB Agency ualifications:
1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
2. Having minimum of three years documented experience.
3. Certified by one of the following:
a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

D. TAB Supervisor and Technician ualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.

B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.

B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.

C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   3. Contract interpretation requests.
   4. Lists of completed tests.

B. Ensure recorded data represents actual measured or observed conditions.

C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 WATER SYSTEM PROCEDURE

A. Adjust water systems to provide required or design quantities.

B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

D. Effect system balance with automatic control valves fully open to heat transfer elements.

E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.

B. Perform prerequisites prior to starting commissioning activities.

C. Fill out Prefunctional Checklists for:
   1. Air side systems.
   2. Water side systems.

D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for percent of the air handlers plus a random sample equivalent to percent of the final TAB report data as directed by Commissioning Authority.
   1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
   2. Use the same test instruments as used in the original TAB work.
   3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
   4. For purposes of re-check, failure is defined as follows:

a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
c. Temperatures: Deviation of more than one degree F.
d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.

5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.

F. In the presence of the Commissioning Authority, verify that:
1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

A. Test, adjust, and balance the following:
1. Plumbing Pumps.
2. HVAC Pumps.
3. Chillers.
4. Cooling Towers.
5. Packaged Roof Top Heating/Cooling Units.
6. Air Coils.
7. Air Handling Units.
8. Fans.
9. Air Terminal Units.
10. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.

B. V-Belt Drives:
   1. Identification/location.
   2. Required driven RPM.
   3. Driven sheave, diameter and RPM.
   4. Belt, size and quantity.
   5. Motor sheave diameter and RPM.
   6. Center to center distance, maximum, minimum, and actual.

C. Pumps:
   1. Identification/number.
   2. Manufacturer.
   3. Size/model.
   4. Impeller.
   5. Service.
   6. Design flow rate, pressure drop, BHP.
   7. Actual flow rate, pressure drop, BHP.
   8. Discharge pressure.
   9. Suction pressure.
   10. Total operating head pressure.
   11. Shut off, discharge and suction pressures.
   12. Shut off, total head pressure.

D. Chillers:
   1. Identification/number.
   2. Manufacturer.
   3. Capacity.
   4. Model number.
   5. Serial number.
   6. Evaporator entering water temperature, design and actual.
   7. Evaporator leaving water temperature, design and actual.
   8. Evaporator pressure drop, design and actual.
   9. Evaporator water flow rate, design and actual.
   10. Condenser entering water temperature, design and actual.
   11. Condenser pressure drop, design and actual.
   12. Condenser water flow rate, design and actual.

E. Cooling Tower:
   1. Tower identification/number.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Rated capacity.
   6. Condenser water entering temperature.
   7. Condenser water leaving temperature.
   8. Condenser water flow rate.
   9. Fan RPM.

F. Heat Exchangers:
   1. Identification/number.
   2. Service.
   3. Manufacturer.
   4. Model number.
   5. Serial number.

6. Primary water entering temperature, design and actual.
7. Primary water leaving temperature, design and actual.
8. Primary water flow, design and actual.
9. Primary water pressure drop, design and actual.
10. Secondary water leaving temperature, design and actual.
11. Secondary water flow, design and actual.
12. Secondary water pressure drop, design and actual.

G. Cooling Coils:
1. Identification/number.
2. Service.
3. Air flow, design and actual.
4. Water flow, design and actual.
5. Water pressure drop, design and actual.
6. Entering water temperature, design and actual.
7. Leaving water temperature, design and actual.
8. Air pressure drop, design and actual.

H. Heating Coils:
1. Identification/number.
2. Service.
3. Manufacturer.
4. Air flow, design and actual.
5. Water flow, design and actual.
6. Entering water temperature, design and actual.
7. Air pressure drop, design and actual.

I. Electric Duct Heaters:
1. Identification/number.
2. Model number.
3. Design kW.
4. Number of stages.
5. Phase, voltage, amperage.
6. Test voltage (each phase).
7. Test amperage (each phase).
8. Air flow, specified and actual.

J. Air Moving Equipment:
1. Manufacturer.
2. Model number.
3. Serial number.
4. Arrangement/Class/Discharge.
5. Air flow, specified and actual.
6. Return air flow, specified and actual.
7. Outside air flow, specified and actual.
8. Total static pressure (total external), specified and actual.
9. Inlet pressure.
10. Discharge pressure.
11. Sheave Make/Size/Bore.
12. Number of Belts/Make/Size.
13. Fan RPM.

K. Duct Traverses:
1. System zone/branch.

2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.

L. Duct Leak Tests:
1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test static pressure.
7. Test orifice differential pressure.
8. Leakage.

M. Air Monitoring Stations:
1. Identification/location.
2. System.
3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

N. Flow Measuring Stations:
1. Identification/number.
2. Location.
3. Size.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Design Flow rate.
8. Design pressure drop.
9. Actual/final pressure drop.
10. Actual/final flow rate.
11. Station calibrated setting.

O. Terminal Unit Data:
1. Manufacturer.
2. Type, constant, variable, single, dual duct.
3. Identification/number.
4. Model number.
5. Size.
6. Minimum static pressure.
7. Minimum design air flow.
8. Maximum design air flow.
9. Maximum actual air flow.
10. Inlet static pressure.

P. Air Distribution Tests:
   1. Air terminal number.
   2. Room number/location.
   3. Terminal type.
   4. Terminal size.
   5. Area factor.
   6. Design velocity.
   7. Design air flow.
   8. Test (final) velocity.
   9. Test (final) air flow.
   10. Percent of design air flow.

END OF SECTION

SECTION 23 0713
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Duct insulation.

B. Duct liner.

C. Weather barrier coatings.

D. Jacketing and accessories.

1.02 REFERENCE STANDARDS

A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).

B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

C. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.

D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.

E. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings 2019 (Reapproved 2022).

F. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers 2015.

G. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

H. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay 2017 (Reapproved 2021).

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

J. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

K. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).

L. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

N. UL 181A - Closure Systems for Use with Rigid Air Ducts Current Edition, Including All Revisions.

O. UL 181B - Closure Systems for Use with Flexible Air Ducts and Air Connectors Current Edition, Including All Revisions.

P. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.05 FIELD CONDITIONS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

A. Manufacturer:
   1. CertainTeed Corporation; : www.certainteed.com/#sle.
   2. Johns Manville; : www.jm.com/#sle.
   3. JP Lamborn Co; Thermal Sleeve MT: www.jpflex.com/#sle.
   4. Knauf Insulation; Atmosphere Duct Wrap: www.knaufinsulation.com/#sle.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

E. Indoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

F. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; : www.certainteed.com/#sle.
   2. Johns Manville; : www.jm.com/#sle.
   3. Knauf Insulation; : www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C612; rigid, noncombustible blanket.

C. Vapor Barrier Jacket:
   1. Kraft paper with glass fiber yarn and bonded to aluminized film.

2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

D. Vapor Barrier Tape:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.04 WEATHER BARRIER COATINGS

A. Weather-Resistive Barrier Coating: Fire-resistive, UV resistant, water-based mastic for use over closed cell polyethylene and polyurethane foam insulation; applied with glass fiber or synthetic reinforcing mesh.
1. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less, Class A, when tested in accordance with ASTM E84.
2. Water Vapor Permeance: Greater than 1.0 perm in accordance with ASTM E96/E96M.
3. Resistance to Fungal Growth: No growth when tested in accordance with ASTM D5590.
4. Color: As selected by Architect.

2.05 JACKETING AND ACCESSORIES

A. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
2. Thickness: 34 mil, 0.034 inch.
3. Finish: Embossed.
4. Color: Silver.
5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
7. Emissivity: 0.30 when tested in accordance with ASTM C1371.

B. Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723 or ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

C. Plain Foil Tape:
1. Aluminum foil with pressure-sensitive adhesive on paper release liner.

D. UL181 Tape for Rigid and Flexible Ductwork:
1. Comply with UL 181A for rigid ductwork.
2. Comply with UL 181B for flexible ductwork.
3. Aluminum foil coated with pressure-sensitive adhesive on paper release liner.
4. Foil tape suitable for sealing seams between insulation, insulated elbows, and fittings resulting in a tight, smooth surface without wrinkles.

2.06 DUCT LINER

A. Note: Choose the liner type - Elastomeric Foam or Glass Fiber.

B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

PART 3 EXECUTION

3.01 EXAMINATION

A. Test ductwork for design pressure prior to applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated Ducts Conveying Air Below Ambient Temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

C. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.

D. Slope exterior ductwork to shed water.

E. Duct and Plenum Liner Application:
   1. Adhere insulation with adhesive for 90 percent coverage.
   2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
   3. Seal and smooth joints. Seal and coat transverse joints.
   4. Seal liner surface penetrations with adhesive.
   5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

A. Exhaust Ducts Within 10 ft of Exterior Openings:

B. Outside Air Intake Ducts:

C. Supply Ducts:

D. Supply Ducts From Fans to Vertical Ducts in Shafts (Cooling System):

E. Supply Ducts in Vertical Shafts (Cooling Systems):

F. Ducts Exposed to Outdoors:

END OF SECTION

SECTION 23 0716
HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

C. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.

D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2023.

E. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.

F. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Manufacturer:
   1. CertainTeed Corporation; : www.certainteed.com/#sle.
   2. Johns Manville Corporation; : www.jm.com/#sle.
   3. Knauf Insulation; Earthwool Insulation Board: www.knaufinsulation.com/#sle.
   4. Owens Corning Corporation; : www.ocbuildingspec.com/#sle.

B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
   1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
   2. Maximum Service Temperature: 1,200 degrees F.
   3. Maximum Water Vapor Absorption: 5.0 percent by weight.
   4. Maximum Density: 8.0 pcf.

C. Aluminum-Foil Laminate Jacket:
   1. Factory-applied, pressure sensitive adhesive jacketing to comply with ASTM C1775.

D. Vapor Barrier Jacket:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
   2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   3. Secure with self-sealing longitudinal laps and butt strips.
   4. Secure with outward clinch expanding staples and vapor barrier mastic.

E. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.

F. Vapor Barrier Lap Adhesive: Compatible with insulation.

G. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:
   1. Aeroflex USA, Inc; Aerocel AC Sheet and Roll: www.aeroflexusa.com/#sle.
   2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
   3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
   1. Minimum Service Temperature: Minus 40 degrees F.
   2. Maximum Service Temperature: 220 degrees F.
   3. Connection: Waterproof vapor barrier adhesive.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Factory Insulated Equipment: Do not insulate.

C. Insulated equipment containing fluids below ambient temperature; insulate entire system.

D. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

E. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.

F. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.

G. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.

H. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

3.02 SCHEDULE

A. Heating Systems:
   1. Heat Exchangers/Converters:
   2. Air Separators:

B. Cooling Systems:
   1. Pump Bodies:

2. Air Separators:
3. Expansion Tanks:
4. Chiller Cold Surfaces (Not Factory Insulated):
5. Cold Thermal Storage Tanks:

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Flexible removable and reusable blanket insulation.

C. Jacketing and accessories.

D. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.

B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019, with Editorial Revision (2023).

C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement 2007 (Reapproved 2019).

D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement 2007 (Reapproved 2019).

E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2022a.

F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2023).

G. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation 2019.

H. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation 2023.

I. ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation 2021.

J. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics 2016 (Reapproved 2023).

K. ASTM D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics 2017 (Reapproved 2023).

L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

M. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).

N. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).

O. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2023).

P. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.

. SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth 2016b.

R. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. K Value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum Service Temperature: 850 degrees F.
   3. Maximum Moisture Absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: Compatible with insulation.

E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

F. Insulating Cement: ASTM C449.

2.03 RIGID, CELLULAR PHENOLIC

A. Manufacturers:
   1. Dyplast Products, LLC; : www.dyplastproducts.com/#sle.
   2. ITW Insulation Systems; : www.itwinsulation.com/#sle.
   3. Polyguard Products; PolyPhen: www.polyguardproducts.com.com/#sle.

B. Insulation: ASTM C1126, Type III, Grade 1.
   1. Nominal Density: 3.75 pcf.
   2. Preliminary Initial Minimum K Value: 0.145 at 50 degrees F based on density of 2.5 pcf.
   3. Maximum Service Temperature: 248 degrees F.
   4. Minimum Service Temperature: Minus 292 degrees F.
   5. Minimum compressive strength as determined by ASTM D1621.
   6. Minimum tensile strength as determined by ASTM D1623.

2.04 JACKETING AND ACCESSORIES

A. ABS Plastic:
   1. Jacket: One piece molded type fitting covers and sheet material, off-white color.

a. Minimum Service Temperature: Minus 40 degrees F.
b. Maximum Service Temperature: 180 degrees F.
c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with ASTM E96/E96M.
d. Thickness: 30 mil, 0.030 inch.
e. Connections: Brush on welding adhesive.

B. Aluminum Jacket:
1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch sheet.
3. Type: Factory-applied, self-adhesive jacketing.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

C. Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723, ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

2.05 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
a. Elastomeric Sleeve Diameter: 1-11/16 inch.
2. Outlet Cover Color: Gray.
3. Water Penetration: Comply with ASTM E331.
4. Air Leakage: Comply with ASTM E283.
5. Air Permeance: Comply with ASTM E2178.

B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
1. PVC Insulation Cover Color: Black with full-length velcro fastener.
2. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Insulated Pipes Conveying Fluids Below Ambient Temperature:
1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

C. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

D. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

E. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.

F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.

G. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

H. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.02 SCHEDULE

A. Heating Systems:
   1. Heating Water Supply and Return: Glass Fiber, Rigid, 2-inch thick.

B. Cooling Systems:
   1. Chilled Water: Rigid, Cellular Phenolic, 2-inch thick

C. Other Systems:
   1. Piping Exposed to Freezing: Class Fiber, Rigid, 2-inch thick with Heat Tracing

END OF SECTION

SECTION 23 0800
COMMISSIONING OF HVAC

PART 1 GENERAL

1.01 RELATED WORK

A. Division 22 - Plumbing

B. Division 26 - Electrical

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 PRODUCTS

2.01 NOT USED

PART 3 EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

I. The CA will review operating and maintenance materials for HVAC systems.

J. The CA will review phasing plans as provided by the GC relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. HVAC System
   1. Chillers
   2. Pumps
   3. Boilers
   4. Cooling Towers
   5. Variable Frequency Drives
   6. Air Handling Units
   7. Energy Recovery Units
   8. VAV boxes
   9. Supply and Exhaust Fans

B. DDC Controls

C. DDC System GUI Compliance

D. Domestic Hot Water System

E. Science Lab Safety Panels

F. Lighting Controls

G. Electric Sub-Metering

3.03 HVAC COMMISSIONING PLAN

A. Commissioning Team
   1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:
      a. Program Manager (PrM)
      b. Facilities Management Division (FMD)
      c. Commissioning Agent (CA)
      d. Design Team (DT)

e. General Contractor (GC)
f. GC's Mechanical Contractor (MC)
g. GC's Controls Contractor (CC)
h. Test and Balance Contractor (TABC)
i. GC's Electrical Contractor (EC)

B. Basis of Design Document
1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings
1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)
1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists
1. The MC will provide SVC's based on manufacturers start-up procedures. These tests should be provided for all systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up
1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting HVAC equipment.

2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring
1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring
1. The preliminary TAB report set-up will be reviewed prior to HVAC equipment start-up, in order to assure that the final TAB report format and content is acceptable.
2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.
3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)
1. The CA will write FPT's based on the respective sequence of operations. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
3. The Functional Performance Tests shall include HVAC and related equipment.
   a. AHU's will be tested in designed operating modes. Proper operation will be verified at minimum OA, maximum OA, automatic control, and other modes, if necessary, to achieve BOD conformance.
   b. Variable Air Volume terminals with and without reheats will be tested at minimum and maximum temperature set points, and under automatic control. Intermediate settings will be tested as necessary.
   c. Chilled water system will be tested in designed operating modes. Proper operation will be verified at minimum loads, maximum loads, waterside economizing mode, Manual control, automatic control, and other modes.
   d. Hot water system will be tested.
   e. EF's will be tested for conformance to BoD.
   f. Hydronic pumps will be tested under relevant operating conditions.
   g. Heat Exchangers will be tested under relevant operating conditions.
   h. DDC control systems will be tested as necessary.
   i. HVAC systems will be tested to assure that the building as an integrated system operates properly.

j. Trend verification of systems and subsystems shall be completed prior to start of functional performance testing. CA will provide trend format to CC and discuss trend requirements in CX meetings throughout the construction phase of project.

4. Deferred Testing
   a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
   b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.
5. Rescheduled Functional Performance Test
   a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed to the contractor as an additional fee of 1500.00 per day.
   b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not pass during the retest, the contractor will be billed at a rate of 1500.00 per day for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training
1. The CA will oversee contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative, and witnessed by the CA. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going HVAC related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. General Contractor (GC)
1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.
6. Assist the CA in monitoring the duct leakage testing.

B. GC's Mechanical Contractor (MC)
1. Each contractor in this division shall include in their quote the cost of participating in the commissioning process.

2. Include requirements for submittal data (including partial load data), O&M data, and training in each purchase order or sub-contract.
3. Assure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, temperature controls, and TAB in commissioning activities.
4. Assure participation of major equipment manufacturers in appropriate startup, training, and testing activities.
5. Attend commissioning meetings scheduled by the CA.
6. Assist the CA in system verification and performance testing.
7. Prepare preliminary schedule for HVAC system inspections, O & M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, system verification, performance testing, and system completion for use by the CA. Update schedule as appropriate throughout the construction period.
8. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of HVAC equipment.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Notify the CA a minimum of two weeks in advance of scheduled system start-up.
11. Update drawings to as-built condition and review with the CA throughout the construction process.
12. Schedule vendor and subcontractor provided training sessions as required by project specifications.
13. Provide written notification that the following work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent.
    a. HVAC equipment including fans, air handling units, dehumidification units, ductwork, dampers, terminal devices, etc.
    b. Fire detection and smoke detection devices furnished under other divisions as they affect the operation of the HVAC systems.
    c. That BAS is functioning in accordance with design intent.
14. Participate in the Functional Performance Tests.
15. Participate in the off-season mode testing.
16. Participate in O&M Training as required by project specifications.
17. Provide a complete set of as-built drawings and O & M manuals for review. The CA shall review the as-built drawings and O&M manuals concurrently with the design team.

C. Test and Balance Contractor (TABC)
1. Include cost for commissioning requirements (participation) in the contract price.
2. Attend commissioning meetings scheduled by the CA.
3. Submit the TAB procedures and preliminary TAB report to the CA for review at least two weeks prior to beginning TAB work.
4. Notify the CA a minimum of two weeks in advance of scheduled TAB work.
5. Provide partial, preliminary TAB Reports by phase, by building section, by system, or as required by the CA.
6. Assist the CA in system verification and performance testing.
7. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
8. Participate in verification of the TAB report, which will consist of repeating any selected measurement contained in the TAB report where required by the CA for verification or diagnostic purposes.
9. Participate in the Functional Performance Tests as required to achieve design intent.

10. Provide sound and vibration where required to assist in diagnosis of areas exhibiting unacceptable levels of noise or vibration.
11. Participate in the off-season mode testing as required to achieve design intent.
12. Participate in O&M Training as required by project specifications.

D. GC's Temperature Control Contractor (TCC)
1. Include cost for commissioning requirements in the contract price.
2. Review control sequence and component selection for conformance with design intent.
   a. Attend a submittal review meeting with the CA and Engineer to ensure clear understanding of scope of work and expectations.
   b. Verify that specified safeties and interlocks have been selected.
   c. Verify proper selection of control valves and actuators based on design parameters.
   d. Verify proper selection of control dampers and actuators based on design parameters.
   e. Verify that sensor selection conforms to design intent.
3. Attend commissioning meetings scheduled by the CA.
4. Provide the following submittals to the CA:
   a. Hardware and software submittals.
   b. Control panel construction shop drawings.
   c. Narrative description of control sequences for each HVAC system and subsystem.
   d. Schematics showing all control points, sensor locations, point names, actuators, controllers and where necessary, points of access.
   e. A list of all control points, including analog inputs, analog outputs, digital inputs and digital outputs. Include the values of all parameters for each system point. Provide a separate list for each stand-alone control unit.
   f. A complete listing of all software routines employed in operating the control system. Also provide a program narrative that describes the logic flow of the software and the functions of each routine and sub-routine. The narrative should also explain individual math or logic operations that are not clear from reading the software listing.
   g. Hardware operation and maintenance manuals.
   h. Application software and project applications code manuals.
   i. Panel and equipment insert documents.
   j. Assist CA with remote monitoring capabilities. Supply any software and/or hardware needed.
5. Verify that specified interfaces provided by others are compatible with BAS hardware and software.
6. Coordinate installation and programming of BAS with construction and commissioning schedules.
7. Complete System Verification Checklists and manufacturer’s pre-start checklists prior to scheduling startup of HVAC equipment.
8. Provide control system technician to assist during equipment startup.
9. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
10. Participate in the Functional Performance Tests as required by the project specifications.
11. Provide a control system technician to assist during verification and performance testing.
12. Provide system modifications to achieve system operation as defined by the design intent.
13. Provide support and coordination for TAB contractor. Provide all devices, such as portable operator terminals and all software for the TAB to use in completing TAB procedures.

14. Provide written notification that the TCC scope of work has been completed in accordance with the project specifications, and that the equipment, systems and sub-systems are operating in accordance with design intent, and that BAS is functioning in accordance with design intent.
15. Participate in the Functional Performance Tests as required to achieve design intent.
16. Participate in the off-season mode testing as required to achieve design intent.
17. Participate in O&M Training as required by project specifications. Include training on hardware operations and programming

END OF SECTION

SECTION 23 0900
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL

1.01 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
      a. Water Temperature: Plus or minus 1 deg F.
      b. Water Flow: Plus or minus 5 percent of full scale.
      c. Water Pressure: Plus or minus 2 percent of full scale.
      d. Space Temperature: Plus or minus 1 deg F.
      e. Ducted Air Temperature: Plus or minus 1 deg F.
      f. Outside Air Temperature: Plus or minus 2 deg F.
      g. Dew Point Temperature: Plus or minus 3 deg F.
      h. Temperature Differential: Plus or minus 0.25 deg F.
      i. Relative Humidity: Plus or minus 5 percent.
      j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
      k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
      l. Airflow (Terminal): Plus or minus 10 percent of full scale.
      m. Air Pressure (Space): Plus or minus 0.01-inch wg.
      n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
      o. Carbon Monoxide: Plus or minus 5 percent of reading.
      p. Carbon Dioxide: Plus or minus 50 ppm.
      q. Electrical: Plus or minus 5 percent of reading.

1.02 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Schedule of dampers including size, leakage, and flow characteristics.
   6. Schedule of valves including flow characteristics.
   7. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   9. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.
   5. Software license required by and installed for DDC workstations and control systems.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ASHRAE 135 for DDC system components.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.05 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

C. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

PART 2 PRODUCTS

2.01 CONTROL SYSTEM

A. Available Manufacturers:
   1. Reliable Controls as installed by Unified Energy Solutions

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network through a standard web broswer via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
   2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      a. Global communications.
      b. Discrete/digital, analog, and pulse I/O.
      c. Monitoring, controlling, or addressing data points.
      d. Software applications, scheduling, and alarm processing.

e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
   d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   e. Remote communications.
   f. Maintenance management.
   g. Units of Measure: Inch-pound and SI (metric).
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

B. Diagnostic Terminal Unit: The control contractor to include 1,000 allowance in the bid for purchase of the diagnostic terminal unit.

C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.
3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation Not standard
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mAnot standard
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
   1. Output ripple of 5.0 mV maximum peak to peak.
   2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
   3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
   1. Minimum dielectric strength of 1000 V.
   2. Maximum response time of 10 nanoseconds.
   3. Minimum transverse-mode noise attenuation of 65 dB.
   4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.03 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   1. Configuration: Diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 4-hour battery backup.
   2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
   3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
   4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
   5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

2.04 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

D. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig.
   2. Proportional band shall extend from 2 to 20 percent for 5 psig.
   3. Authority shall be 20 to 200 percent.
   4. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.05 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Space Temperature Sensor (Thermostat):
   1. Thermistor with resistance of 10,000 ohms at 77□F.
   2. Accuracy shall be +/-1/2□F.
   3. Range of 55□ to 95□ F.
   4. Provide manufacturers calibration certificate.
   5. Front covers without displays throughout the building.
   6. Temperature Indicator:
      a. Offices: Numeric LED
      b. Classrooms: None
      c. Public Areas: None
   7. Setpoint Adjustment:
      a. Offices: Push Button
      b. Classrooms: None
      c. Public Areas: None
   8. Occupant Override:
      a. Offices: Push Button
      b. Classrooms: None
      c. Public Areas: None
   9. Ventilation ring for fast response
   10. Jack at sensor for communications
   11. Location and height to be approved by Engineer prior to installation
   12. Color to be approved by Engineer/Owner. Submit a sample to reviewed by owner. Acceptance of sample shall be in writing to contractor.
   13. Provide ventilated locking clear plastic guards in the following locations:
      a. Cafeteria
      b. Kitchen/Serving Lines
      c. Gymnasium
      d. Dressing/Locker Rooms/Weight Rooms
      e. Industrial Labs
   14. Provide an insulated sensor wall plate to fully cover wall opening. Back cover plate shall match sensor color.
   15. Where indicated on drawings to provide both space temperature and space humidity, a combination temperature sensor shall be provided.

C. Thermistor Temperature Sensors and Transmitters:
   1. Accuracy: Plus or minus 0.5 deg F at calibration point.
   2. Wire: Twisted, shielded-pair cable.
   3. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
   4. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
   5. Averaging Elements at coils: Flexible type serpentine across the entire face of the coil, (minimum of 2-passes).
   6. Freeze Stats: Flexible type serpentine across the entire face of the coil every six inches on center.
   7. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

D. Outside Air Temperature and Humidity Sensor:
   1. Temperature
      a. Range of –40□ to 140□F.
      b. Accuracy shall be +/-0.9□F
      c. Encapsulated into Type 304 stainless steel tubes with low conductivity moisture proofing material and lag extension for thickness of insulation.
   2. Humidity
      a. Capacitance element in the space or duct as required and output a 4 to 20 MA signal proportional to 0 to 100% RH to the DDC.
      b. Accuracy shall be +/-2%
      c. Range from 20 to 95% RH.
      d. Relative humidity sensors shall have the sensing element of inorganic resistance media.
   3. Weatherproof sun shield consisting of multiple white plastic plates to reduce the thermal effects of the sum and increasing air flow between the plates.
   4. Sensor shall be mounted a minimum of 6” from all building structures.
   5. Minimum of 8' long leads.
   6. Provide manufacturers calibration certificate.
   7. Provide with a 5-year warranty

E. Humidity Sensors: Bulk polymer sensor element.
   1. Accuracy: 2 percent full range with linear output.
   2. Room Sensor Range: 20 to 80 percent relative humidity.
   3. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
   4. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F
   5. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

F. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.
   1. Bulb Length: Minimum 20 feet.
   2. uantity: One thermostat for every 20 sq. ft. of coil surface.

G. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.
   1. Bulb Length: Minimum 20 feet.
   2. uantity: One thermostat for every 20 sq. ft. of coil surface.

H. Pressure Transmitters/Transducers:
   1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
      a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
      b. Output: 4 to 20 mA.
      c. Building Static-Pressure Range: 0- to 0.25-inch wg.
      d. Duct Static-Pressure Range: 0- to 5-inch wg.
   2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
   3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.

4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.06 STATUS SENSORS

A. Status Inputs for Fans: Current Switches. See below for requirements. Provide a current switch on each fan motors with a multiple fan AHU.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches:
1. Ensure compatibility with VFD applications for variable speed motor status.
2. Provide with adjustable set point.
3. Relays must be mounted and not hung by power wires thru CT.
4. Provide split-core type.
5. Loop powered.
6. LED Status.
7. Relays shall close status contacts in response to current flow in power leads to the equipment being monitored.

G. Current Transducers:
1. Ensure compatibility with VFD and ECM applications for variable speed motor status and current.
2. Provide with adjustable set point capable of reading lowest required amperage.
3. The current sensor shall be a split core type with self-gripping iris that adheres to the electrical conductor.
4. Provide split-core type.
5. Loop powered.
6. The current sensor shall be fixed 0-10A and output of 0-10 VDC.
7. LED Status.
8. Transducer shall provide a current reading to BMCS.

H. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

I. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.07 FLOW MEASURING STATIONS

A. Electromagnetic Hydronic Flow Meters:
1. Retractable hot tap flow sensor
2. Accuracy: +/- 1% of full scale
3. Custom thread-o-let 400 psi / 250°F rated
4. Installed into a 1” full port ball valve

5. Provided with an insertion depth gage
6. Line size from 2-1/2 to 72 inches
7. Metering range from 0.1 to 20 f/sec (200:1 turndown).
8. Remote NEMA 4 wall mounted LCD display. Mounted on wall at 5’-6” above finished floor.
9. Field Pro Software & Communicator
10. Warranty two years
11. Approved Manufacturer: Onicon Electromagnetic Flow Meter F-3500 Series

B. Cooling Tower Pulse Water Meters:
   1. General:
      a. Multi-jet principle.
      b. A gear train drives the register totalizer dials.
      c. Changing the pulse rate requires no special tools and can be done in the field.
      d. Solid-state, hall-effect sensor.
   2. Power: 6mA at 12 VdcTemperature: 105F Max.Pressure: 150 psiMaterials:Body: Cast Bronze, Epoxy powder coated inside and out.Internals: Engineered thermoplasticMagnet: AlnicoAccuary +/- 1.5% of readingPulse output:Max Current: 20 mAMax Voltage: 24 Vdc or VacFlow Rates:Make-up water meter: 132 gpm (2” meter)Chemical treatment blowdown: 52 gpm (1” meter)
   3. Temperature: 105F Max.
   4. Pressure: 150 psi
   5. Materials:
      a. Body: Cast Bronze, Epoxy powder coated inside and out.
      b. Internals: Engineered thermoplastic
      c. Magnet: Alnico
   6. Accuary +/- 1.5% of reading
   7. Pulse output:
      a. Max Current: 20 mA
      b. Max Voltage: 24 Vdc or Vac
   8. Flow Rates:
      a. Make-up water meter: 125 gpm max
      b. Chemical treatment blowdown: 50 gpm max

C. Duct Airflow Station: Shall be traverse probe(s) type capable of continuously monitoring the fan or duct capacities served. Probe(s) shall contain multiply total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to the respective averaging manifolds. Flow sensors shall not protrude beyond surface of probe(s), and shall be the offset (Fechheimer) type for static pressure and the chamfer impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by the direcitional flow having pitch and/or yaw angles up to 30deg. Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket, and signal fittings suitable for HVAC duct installation. Probes shall be AMCA certified and be capable of measuring the airflow rates within an accuracy of +/- 2% without the use of correction factors. The maximum allowable unrecovered pressure drop caused by the probes shall not exceed 0.025" w.c. at 2000 FPM, or 0.085" w.c. at 4000 FPM.

2.08 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Valves: Size for torque required for valve close off at maximum pump differential pressure.
2. Dampers: Size for running torque calculated as follows:
a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
3. Coupling: V-bolt and V-shaped, toothed cradle.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
6. Power Requirements (Two-Position Spring Return): -V ac.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: Minus 22 to plus 122 deg F .
10. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
11. Run Time: 12 seconds open, 5 seconds closed.

2.09 CONTROL VALVES

A. Ball Valves with Characterized Disk and Threaded Ends.
1. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:
a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 75 percent open.
c. Flow Characteristic: Equal percentage.
d. Leakage: Zero percent.
e. Hydronic Pressure:
1) Rating: Nominal 400 psig.
2) Close-off Pressure: 200 psig.
3) Pressure Differential (Maximum): 50 psig.
3. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass with nickel plating.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension:
    1) Material to match ball.
    2) Blowout-proof design.
    3) For valves installed in insulated piping systems, provide stem extension.
    4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

B. Ball Valves with Characterized Disk and Flanged Ends, Two Way:
1. Source Limitations: Obtain two-way ball valves, with characterized disk and flanged ends, from single manufacturer.
2. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: Zero percent.
    e. Hydronic Pressure:
        1) Rating: In accordance with ASME B16.1, Class B.
        2) Close-off Pressure:
            (a) Class 125: 175 psig.
        3) Pressure Differential (Maximum): 50 psig.
3. Construction:
    a. Size Range: NPS 2-1/2 to NPS 6.
    b. Body: Cast iron, Class B in accordance with ASME B16.1.
    c. End Connections: Flanged, Class 125 or 250 in accordance with ASME B16.1.
    d. Ball: Stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Characterizing Disk: Stainless steel.
    g. Stem and Stem Extension: Material to match ball; blowout-proof design.
    h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

C. Ball Valves with Characterized Disk and Threaded Ends, Three Way:
1. Source Limitations: Obtain three-way ball valves, with characterized disk and threaded ends, from single manufacturer.
2. Performance:
    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristics:
        1) A-Port: Equal percentage.
        2) B-Port: Modified for constant common port flow.

d. Leakage: Zero percent for A-port; two percent for B-port.
e. Hydronic Pressure:
1) Rating: Nominal 400 psig.
2) Close-off Pressure: 200 psig.
3) Pressure Differential (Maximum): 50 psig.

3. Construction:
a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass with nickel plating.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Stainless steel.
g. Stem and Stem Extension:
1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension.
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.
h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

D. Vave Sizing: By Automatic Control System Manufacturer for fully modulating operation.
1. Minimum pressure drop: Equal to pressure drop of coil or exchanger.
2. Maximum pressure drop: 5 psi.
3. Relief and bypass valves: Sized according to pressure available.
4. 2-position valves: Line size.
5. Manual by-pass operator.

2.10 CONTROL DAMPERS

A. Model: Ruskin CD50 or equal.

B. Rating:
1. Leakage Rating: Class 1A.
2. Temperature Rating: Withstand -22 to 122 degrees F.
3. Capacity: Damper shall withstand system operating conditions
4. Closed Position: Maximum pressure of 13 inches w.g. a 12 inches blade length.
5. Open Position: Maximum air velocity of 6,000 feet per minute.
6. Pressure Drop: Maximum 0.03-inch w.g. at 1,500 feet per minute across 24 inch x 24 inch damper.

C. Construction:
1. Frame: 5 inches x 1 inch x minimum 0.125 inch 6063-T5 extruded aluminum hat channel with hat mounting flanges on both sides of the frame, reinforced at corners.
2. Blades:
a. Style: Airfoil-shaped, single-piece.
b. Action: Opposed.
c. Material: Heavy duty 6063-T5 extruded aluminum.
d. Width: Maximum 6 inches.
3. Bearings: Molded synthetic sleeve, turning in hole in frame.
4. Seals:

a. Blade: Extruded Ruskiprene type for ultra-low leakage from -22 to 122 degrees F. Mechanically attached to blade edge.
b. Jamb: Flexible metal compression type.

5. Linkage: Concealed in frame.
6. Axles: Minimum □ inch diameter plated steel, hex-shaped, mechanically attached to blade.

2.11 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."Insert your information from the other spec
   1. Acceptable manufacturers:
      a. Belden
      b. West Penn
      c. Alpha
   2. All unitary-to-unitary zone communication cabling shall be a minimum of 18 AWG. All other sizing of cabling shall be according to manufacturer's recommendation.
   3. Wall space temperature sensor cabling (from the sensor to the unitary controller) shall have a minimum of four (4) conductors.
   4. All cabling shall be stranded, Solid conductors are not allowed.
   5. All cabling shall be 100% shielded with appropriate drain wire and insulation.
      a. Terminate shields per manufacturer's recommendation.
   6. Refer to Division 27 Section "Voice/Data Systems" for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

3.02 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. Install guards on thermostats in the following locations: (as noted on plans)
   1. Gyms.
   2. Refer to drawings for additional locations.

E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

I. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install electrical wiring and cabling according to Division 26 Section "Conductors Identifications, Splicing Devices and Connectors".
   1. Provide all power wiring for temperature controls system including but not limited to the following.
      a. Power for control panels.
         1) Power for controls for controls must be from circuits in electrical panels, (taking power from receptacles, lighting or equipment circuits is not acceptable).
         2) Label control circuits within electrical panels.
      b. Power for unitary controllers,(including all terminal devices).
         1) Power taken from the equipment it's served is acceptable provided that power is not interrupted to the electronics if the terminal unit is off for any reason.
      c. Interlock wiring including on/off control of chillers, boilers, pumps, fan-coil units, zone controls, cooling towers, etc.
      d. Provide 110 VAC duplex receptacle for all temperature control panels.

D. Install signal and communication cable according to Division 27 Section "Voice/Data Systems."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install cable from wall mounted device, (i.e. thermostat, temperature sensor, etc.) to above ceiling in raceway.
      a. If installing new devices on existing masonry walls, conceal cabling in raceways.
         1) In finished areas use surface mounted race similar to wiremold (i.e. office, classroom).
         2) In unfinished areas use conduit, (i.e. mechanical rooms).
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

E. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

F. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.05 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 0930
KITCHEN-HOOD VENTILATION CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes Kitchen Hood Ventilation Control Systems.

1.02 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Comply with the requirements of Division 01 Section Submittal Procedures.

C. Submit the following for approval:
   1. Product Data Sheets including the following data if applicable:
      a. Electrical Ratings
      b. Dimensions
      c. Weights
      d. Loads
      e. Required Clearances
      f. Field Connections
   2. Shop Drawings:
      a. Indicate hoods, exhaust, and supply equipment being controlled by the system.
      b. Indicate locations of sensors, system controller, VFDs and other components.
      c. Provide wiring diagrams for power, signal, and control wiring.
      d. Provide a description of Sequence of Operation
   3. Installation Instructions
      a. Indicate Installation Procedures and Scopes of Work
   4. Reference Information:
      a. Intelli-Hood Operation and Maintenance Manual.
      b. Sample Startup Report
      c. VFD Manuals

1.03 QUALITY ASSURANCE

A. All electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Control System shall be tested and certified to conform to the following standards.
   1. UL2017 – Standard for General-Purpose Signaling Devices and Systems.
   2. UL710– Standard for Exhaust Hoods for Commercial Cooking Equipment.

1.04 COORDINATION

A. Coordinate installation of hood sensors in kitchen hoods listed in Division 11 Food Service Equipment.

B. Coordinate installation of the System Controller(s), Touchpad(s), and Aux Touchpad(s)

C. Coordinate installation of Variable Frequency Drives

D. Coordinate installation of hood sensor wiring

E. Coordinate power wiring of System Controller, Auxiliary Power Supplies, and Auxiliary Light Controllers.

F. Coordinate VFD and motor power wiring.

G. Coordinate installation of VFD control wiring.

H. Coordinate installation and connections of control wiring for make-up air unit(s), air handling unit(s), pollution control exhaust fan, and any other HVAC equipment related to the kitchen ventilation system.

I. Coordinate supply fan speed and/or damper control of make-up air units or other air handlers to maintain building balance as exhaust fans modulate in speed.

J. Coordinate installation and control wiring of special hood systems such as water wash systems, ultraviolet light cleaning systems, back draft damper systems, etc.

K. Coordinate fire mode interlock and Sequence of Operation.

L. Coordinate interface of Intelli-Hood Control system to building automation network via BACnet protocol over TCP/IP

M. Coordinate connection of Intelli-Hood Control System to an internet gateway such that Intelli-Hood System Controller can connect to the Melink Intelli-Hood Server.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers of the kitchen ventilation control system are:
   1. Melink Corporation: www.melinkcorp.com, 5140 River Valley Rd. Milford OH, 45150, phone: (513) 965-7300:

2.02 SYSTEM DESCRIPTION

A. The kitchen hood Demand Control Kitchen Ventilation (DCKV) control system shall the Melink Intelli-Hood□ system to include controls that sense temperature and smoke under the hood and vary the fan speed to maintain safe and effective kitchen exhaust per ASHRAE / ANSI / IES Standard 90.1 2010. Melink Intelli-Hood□ Demand Control Kitchen Ventilation (DCKV) control system shall monitor cooking activity under the kitchen hood via auto-calibrated infrared Optic Sensors consisting of an Emitter and Receiver mounted on either side of the hood canopy as well as duct or canopy mounted three-wire Temperature Sensor. System shall be capable of operating exhaust fan motors at minimum speeds of 30%-50%. Optic Sensors, with dedicated Air Purge Units, shall immediately increase fan speeds to 100% upon detection of smoke or effluent in the hood canopy, upon evacuation of smoke or effluent the fans will modulate according to exhaust temperature for optimal energy savings. Temperature probes have patented Auto-Calibration feature to automatically adjust ranges via self-learning algorithms to ensure efficient operation of the kitchen ventilation system. System will actively modulate makeup airflow according to exhaust load to maintain correct space airflow balance. Demand Control Kitchen Ventilation (DCKV) system that only includes a temperature sensor to detecting cooking activity shall not be permitted. Additionally, a DCKV system that includes infrared sensors without a dedicated air purge unit and auto-recalibration of sensors shall not be permitted. Modulating dampers, automatic balancing dampers, or other devices that may impede exhaust airflow and grease extraction may not be permitted.

B. Factory assembled, modular, control system, consisting of the following components:
   1. System Controller
      a. Communicates to Hood Controller, Touchpad(s), Temperature and Optic Sensors via proprietary RS-485 Protocol.
      b. Controller capable of communicating with up to (39) Hood Controllers, (10) Touchpads, (10) Auxiliary Touchpads, (10) Auxiliary Power Supplies, and (10) Auxiliary Light Controllers.
      c. Communicates with up to (64) Variable Frequency Drives via Modbus Protocol.
      d. Programmable I/O containing (3) Digital Inputs, (4) Digital Outputs, (1) Analog Input and (1) Analog Output.
      e. Adjustable Temperature range vs. Fan Speed Curve.

f. Automatic On/Off based on hood temperature or programmable clock for individual fan schedules.
g. Removable USB memory storage for setup files and operational performance history data.
h. Calculates appropriate speeds for exhaust and supply fans based on cooking temperature demand and optical infrared monitoring.
i. Internet-based Service Application for monitoring, programming and troubleshooting.
j. BACnet over TCP/IP Interface for communication to Building Automation System.

2. Hood Controller
   a. Monitors Temperature and Optic Sensors on each kitchen hood and sends the sensor data to the System Controller via RS-485 Protocol communications.
   b. Steel beam clamps for installation on hoods or other mechanical structures above kitchen hood.
   c. Hood Controller Temperature Rating: 0° to 50°C, 32° to 120°F
3. Temperature Sensor
   a. Platinum three-wire resistive temperature device (RTD) encased in stainless steel tube.
   b. Temperature probes with patented Auto-Calibration technology to self-program based on temperature range data.
   c. Threaded housing shall be assembled in UL-Listed grease-tight fittings for installation in exhaust duct or kitchen hood canopy.
   d. Temperature sensors shall be wired to Hood Controller via 8-pin, RJ-45 connectors to the RS-485 Protocol Hood Network Cables.
   e. Temperature Rating: 0° to 535°C, 32° to 1000°F
4. Optic Sensors
   a. Optic Sensors shall consist of conformal coated Emitter and Receiver boards housed in stainless steel enclosures on opposite ends of the kitchen hood interior.
   b. Infrared sensors capable of detecting effluent in the air at any point along the length of the beam with a response time of 0.2 seconds.
   c. Sensors shall be capable of spanning 3 to 40 feet of kitchen hood interior with automatic gain adjustment.
   d. Optic sensors shall auto-calibrate every day at start up and/or every 24 hours.
   e. Sensors shall be wired to Hood Controller with liquid-tight connectors at sensor board via the Air Purge Unit.
   f. Optic Sensor Temperature Rating: 0° to 85°C, 32° to 185°F
5. Air Purge Unit (APU)
   a. Air Purge Unit (APU) consisting of a 12VDC blower and interface PCB inside an 18 gauge galvanized steel enclosure shall be installed to reduce the accumulation of contamination on the Optic Sensor lenses and reduces heat buildup inside the Optic Sensor enclosure.
   b. APU shall physically connect to the Optic Sensor enclosure via stainless steel conduit pipe.
   c. Blower fan bearings shall be permanently lubricated.
   d. APU Temperature Rating: 0° to 50°C, 0° to 125°F
6. Touchpad
   a. Full color screen, 2.8” diagonal, VGA resolution screen to display operating status and programmable menus.
   b. Integrated membrane FANS switch for turning fans from Active Mode (On) and Standby Mode (off).
   c. Soft keys and Directional integrated membrane switches for user to boost fans to full speed, access programming menus, access diagnostic and help screens.

d. Fully programmable graphical interface to conform to operators' hood and fan nomenclature.

7. Aux Power Supply
   a. Aux Power Supply shall be used for large installations when additional power is needed to power Hood Controllers, Optic Sensors and Touchpads.
   b. Aux Power Supply Temperature Rating: 5° to 40°C, 41° to 104°F

2.03 VARIABLE FREQUENCY DRIVES

A. Melink Corporation shall furnish VFDs that comply with Division 23 Section 0930, Variable Frequency Drive Specification.

B. Melink Corporation furnished VFDs shall control the VFDs via Modbus Protocol, unless otherwise specified.

C. Building Automation System may acquire VFD control data (stop, start, speed, fault status) from Intelli-Hood System Controller via BACnet Protocol over TCP/IP Communication. BACnet PICS available upon request.

PART 3 EXECUTION

3.01 INSTALLATION SCOPES OF WORK

A. Refer to matrix on drawings for responsibilities and scopes of work of divisions.

3.02 STARTUP SERVICE

A. A Factory-Authorized Service Representative shall perform startup service including:
   1. Inspection of installed components. Verification of correct installation and operation.
   2. Programming of system parameters for proper detection of cooking conditions.
   3. Programming of system parameters for proper operation of control input/output points.
   4. Programming of VFD parameters for proper control communication with control system.
   5. Programming of VFD motor operational set points (maximum speed and allowable motor current).
   6. Verification of Intelli-Hood system functionality.
   7. Results shall be captured in a written report.

3.03 ADJUSTING

A. Test and Balance Contractor shall adjust hood dampers, fan pulleys, and/or VFDs to achieve maximum design airflow at maximum speed.

3.04 DEMONSTRATION

A. A Factory-Authorized Service Representative shall train Owner's maintenance personnel to adjust, operate, and maintain Packaged Kitchen Hood Ventilation Control Systems. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION

SECTION 23 0934
VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.

B. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code) 1989 (Corrigendum 2019).

B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).

E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives 2020.

F. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems 2022.

G. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems 2021.

H. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems 2005.

I. NEMA MG 1 - Motors and Generators 2021.

J. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

K. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures Current Edition, Including All Revisions.

M. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

N. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2) Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
   2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
   3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
   4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.

5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.

C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include wiring diagrams showing factory and field connections.

D. Specimen Warranty: Submit sample of manufacturer's warranty.

E. Manufacturer's equipment seismic qualification certification.

F. Manufacturer's certification that products meet or exceed specified requirements.

G. Field quality control test reports.

H. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

I. Executed Warranty: Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Provide minimum Five year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ABB.

B. Toshiba.

C. Danfoss.

D. Substitutions: See Section 01 6000 - Product Requirements.

E. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Variable-Frequency Motor Controller:
   1. Configuration: Packaged controller with across-the-line bypass.
   2. Rectifier/Converter: Diode-based, 6-pulse type.
   3. Control Method: Scalar/volts per hertz; open-loop, without feedback.
   4. Filtering: Provide input/line reactor and output/load reactor.

D. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

E. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
   1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
   2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
   3. Motor nameplate data.
   4. Requirements for speed control range, speed regulation, and braking.
   5. Motor suitability for bypass starting method, where applicable.

F. Single Controllers Serving Multiple Motors:
   1. Control Method: Scalar/volts per hertz; do not use vector control method.
   2. Provide separate overload relay for each motor; provide auxiliary contacts and control wiring as required to shut down controller upon trip of any single overload relay.
   3. Consider combined length of motor leads for cable length limits.

G. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

H. Operating Requirements:
   1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
   2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
   3. Efficiency: Minimum of 96 percent at full speed and load.
   4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
   5. Overload Rating:
      a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
      b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.

I. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
   1. Rectifier/Converter: Diode-based, 6-pulse type with 5 percent reactor unless otherwise indicated.

J. Control System:
   1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
   2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
   3. Control Functions:
      a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.

1) Scalar/Volts per Hertz Control: Provide IR compensation or torque boost for improved low-speed torque.
2) Vector Control: Provide selectable autotuning function.

b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
c. Selectable braking control; DC injection or flux braking.
d. Adjustable minimum/maximum speed limits.
e. Adjustable pulse width modulation switching carrier frequency.
f. Adjustable motor slip compensation.
g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.

4. Status Indications:
   a. Motor run/stop status.
   b. Motor forward/reverse status.
   c. Hand/Auto control status.
   d. Output voltage.
   e. Output current.
   f. Output frequency.
   g. DC bus voltage.
   h. Motor speed.
5. Protective Functions/Alarm Indications:
   a. Overcurrent.
   b. Motor overload.
   c. Undervoltage.
   d. Overvoltage.
   e. Controller overtemperature.
   f. Input/output phase loss.
   g. Output short circuit protection.
   h. Output ground fault protection.
6. Inputs:
   a. Digital Input(s): .
   b. Analog Input(s): Two.
7. Outputs:
   a. Analog Output(s): Two.
   b. Relay Output(s): Three.
8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
   a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
   b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.
   c. Remote Monitoring Capabilities:
      1) Motor run/stop status.
      2) Hand-off-auto status.
      3) Fault information.
      4) Discrete input/output status.
      5) Analog input/output values.
9. Features:
   a. Password-protected security access.
   b. Event log.

K. Power Conditioning/Filtering:

1. Provide 5-percent DC link chokes or 5-percent input/line reactor for each controller unless otherwise indicated or required.
2. Reactor Impedance: 5 percent, unless otherwise indicated or required.

L. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
   a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
   b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
   c. The drive and bypass packaged shall have a UL listed short circuit current rating of 100 kA, for 240VAC and 480 VAC systems, and this rating shall be indicated on the rating label.
   d. Provide auxiliary interlock for disconnection of external control power sources where applicable.
2. Provide door-mounted remote operator interface.
3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
   a. Bypass Method: Manual, unless otherwise indicated.
   b. Bypass Configuration: Drive isolation fuses shall be provided. Bypass designs which have no such fuses, or that only incorporate fuses common to both the drive and the bypass are not acceptable. Third contactor “isolation contactors” and service switch are not an acceptable alternative to drive isolation fuses.
   c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated. The bypass shall be able to detect a single-phase input power condition while running in bypass, disengage the motor, and provide a single-phase input power indication.
   d. Overload Relays: Selectable Class 10, 20, or 30 electronic motor overload protection shall be included in both drive and bypass mode..
4. Independent Bypass Keypad Requirements:
   a. The bypass shall include a two-line, 20-character LCD display. The display shall allow the user to access parameters and view:
      1) Bypass input voltage, current (Amps) and power (kW)
      2) Bypass faults, warnings, and fault log
      3) Bypass operating time and energy consumption (resettable)
   b. The bypass control panel shall include the following controls:
      1) Four navigation keys (Up, Down, Enter, Escape)
      2) Bypass Hand-Off-Auto, Drive mode / Bypass mode selectors, Bypass reset
   c. The following indicating lights (LED type) or control panel display indications shall be provided.
      1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
      2) Motor Control Selector Switch: HAND/OFF/AUTO.
      3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
      4) Safety interlock and run permissive status shall be displayed using predetermined application specific nomenclature, such as: Damper end switch, smoke alarm, vibration trip, and overpressure.
      5) The bypass shall be designed for stand-alone operation and be completely functional in both Hand and Automatic modes, even if the drive and/or drive’s control board has failed. Network communications shall remain functional. Bypass systems that do not maintain full functionality in the event of a drive failure, are not acceptable.

M. Service Conditions:
   1. Provide controllers and associated components suitable for operation under following service conditions without derating:
      a. Altitude: Less than 3,300 feet.
      b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
   2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

N. Short Circuit Current Rating:
   1. Provide controllers with listed short circuit current rating not less than available fault current at installed location as indicated on drawings.
   2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

O. Conductor Terminations: Suitable for use with conductors to be installed.

P. Enclosures:
   1. Comply with NEMA ICS 6.
   2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
      a. Indoor Clean, Dry Locations: Type 1 or Type 12.
      b. Outdoor Locations: Type 3R or Type 4.
   3. Finish: Manufacturer's standard unless otherwise indicated.
   4. Cooling: Forced air or natural convection as determined by manufacturer.

. Instrument Transformers:
   1. Comply with IEEE C57.13.
   2. Select suitable ratio, burden, and accuracy as required for connected devices.
   3. Current Transformers: Connect secondaries to shorting terminal blocks.
   4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Circuit Breakers:
   1. Molded Case Circuit Breakers:
      a. Description: uick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489; ratings, configurations, and features as indicated or as required.
         1) Provide thermal magnetic circuit breakers unless otherwise indicated.
      b. Interrupting Capacity:
         1) Provide circuit breakers with a 100 KAIC interrupting capacity as required to provide short circuit current rating indicated, but not less than specified minimum requirements.
         2) Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than short circuit current rating indicated.
         3) Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than short circuit current rating indicated.
      c. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
      d. Provide following features and accessories where indicated or where required to complete installation:
         1) Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2) Auxiliary Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped or been turned off.
3) Undervoltage Release: For tripping circuit breaker upon predetermined drop in coil voltage with field-adjustable time delay to prevent nuisance tripping.
4) Alarm Switch: SPDT switch suitable for connection to system indicated for indicating when circuit breaker has tripped.

2.04 SECURITY FEATURES:

A. The drive manufacture shall clearly define cybersecurity capabilities for their products.

B. The drive shall include password protection against parameter changes.
   1. There shall be multiple levels of password protection including: End User, Service, Advanced, and Override.
   2. The drive shall support a customer generated unique password between 0 and 99,999,999.
   3. The drive shall log an event whenever the drive password has been entered.
   4. The drive shall provide a security selection that prevents any “back door” entry. This selection even prevents the drive manufacturer from being able to bypass the security of that drive.
   5. A security level shall be available that prevents the drive from being flashed with new firmware.

2.05 NETWORK COMMUNICATIONS:

A. The drive shall have an EIA-485 port with removable terminal blocks. The onboard protocols shall be BACnet MS/TP, Modbus, and Johnson Controls N2. Optional communication cards for BACnet/IP, LonWorks, Profibus, Profinet, EtherNet/IP, Modbus TCP, and DeviceNet shall be available. The use of third party gateways are not acceptable.

B. The drive shall have the ability to communicate via two protocols at the same time, one onboard protocol and one option card based protocol. Once installed, the drive shall automatically recognize any optional communication cards without the need for additional programming.

C. The drive shall not require a power cycle after communication parameters have been updated.

D. The embedded BACnet connection shall be a MS/TP interface. The drive shall be BTL Listed to Revision 14 or later. Use of non-BTL Listed drives are not acceptable.

E. The drive shall be classified as an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
   1. Data Sharing: Read Property Multiple-B, Write Property Multiple-B, COV-B
   2. Device Management: Time Synchronization-B
   3. Object Type Support: MSV, Loop

2.06 SOURCE QUALITY CONTROL

A. See Section 01 4000 - uality Requirements, for additional requirements.

B. Factory test controllers in accordance with NEMA ICS 61800-2.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that ratings of controllers are consistent with indicated requirements.

C. Verify that mounting surfaces are ready to accept controllers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 23 0529.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 26 0526.

H. Install field-installed devices, components, and accessories.

I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

J. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 START-UP

A. Start-up shall be provided for each drive by an authorized local service provider.

3.04 FIELD QUALITY CONTROL

A. Provide services of manufacturer's authorized representative to perform inspection and testing. Include manufacturer's reports with submittals.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

D. Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.

E. Correct deficiencies and replace damaged or defective controllers or associated components.

3.05 PRODUCT SUPPORT

A. Factory trained application engineering and service personnel that are thoroughly familiar with the drive products offered shall be locally available at both the specifying and installation locations. A toll free 24/365 technical support line connected to factory support personnel located in the US and Canada shall be available.

B. Training shall include installation, programming and operation of the drive, bypass and network communications. Owner training shall be provided locally upon request.

END OF SECTION

SECTION 23 0993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.02 DEFINITIONS

A. CHWS: Chilled Water Supply

B. CHWR: Chilled Water Return

C. CWS: Condenser Water Supply (Supply to chiller)

D. CWR: Condenser Water Return

E. DDC: Direct digital control.

F. DPT: DewPoint Temperature

G. HWS: Hot Water Supply

H. HWR: Hot Water Return

I. VAV: Variable air volume.

J. BAS: Building Automation System.

K. VFD: Variable Frequency Drive or Controller.

L. VFC: Variable Frequency Drive or Controller.

M. VFV: Variable Refrigerant Volume.

N. TAB: Test and Balance

O. FMS: Facility Monitoring System.

1.03 TRENDING FOR BUILDING COMMISSIONING

A. All diagnostic trends listed in this document shall be provided to the commissioning agent in excel (.EXE) format during the commissioning process. Coordinate additional requirements with commissioning authority prior to programming.

1.04 DISPLAY GRAPHICS

A. Provide display graphics for review with shop drawing submittals.

1.05 MODE OF OPERATION

A. Occupied:

B. Unoccupied:

C. Morning Start-up:

1.06 VARIABLE PRIMARY CHILLED WATER SYSTEM SEQUENCES

A. General:
   1. The chilled water system consists of three (3) 400-ton variable speed chillers. A primary, variable-flow chilled water pumping system will be utilized with a system bypass valve.
   2. All chiller systems shall be either automatically started/stopped by the DDC controls system or manually started/stopped by the system operator.

a. When in the automatic mode, the chilled water system shall operate in a Lead/Lag1/Lag2 arrangement with the Lead chiller rotating weekly.

3. Various points of control shall be “Hardwired” to/from the chiller. Those points shall include but not be limited to:
   a. Inputs:
      1) Chiller(s) start-stop
      2) Chiller demand limit
   b. Outputs:
      1) Chiller failure alarm
      2) Current output to determine percent of chiller is fully loaded.
4. Interface with chiller manufacture BACNET interface, display relevant data on a separate web page.

B. Chilled Water System Operations: The chilled water system shall be called to operate under the following conditions:
   1. Occupied: When 15% (adjustable from chilled water system web page) of air handling units require cooling. An air handling unit is requiring cooling under the following conditions.
      a. VAV Air Handling Unit (Unit with terminal box for zone control): When 15% of zones are above setpoint.
      b. Single Zone AHU (Fan-coils not included): When the zone is above setpoint.
   2. Un-occupied: When 20% (adjustable from chilled water system web page) of air handling units require cooling. An air handling unit is requiring cooling under the following conditions.
      a. VAV Air Handling Unit (Unit with terminal box for zone control): When 20% of zones are above the un-occupied setpoint.
      b. Single Zone AHU (Fan-coils not included): When the zone is above setpoint.

C. Chilled Water System Start-up Sequence: The following shall occur in sequential order:
   1. Control valves on active air handling units shall open to 50% flow, (refer to AHU and OA sequences for additional info).
   2. Initiate Condenser Water System start sequence for Lead chiller.
   3. The lead chiller(s) evaporator 2-way, 2-position control valve shall open and Primary chilled water pump(s) shall start. The control valve shall be slow acting and be programed to open over a 5-minute period.
      a. The chiller(s) evaporator 2-way, 2-position control valve shall be provided with a position verification switch, a start signal shall not be sent to the chiller until verification that the chiller control valve is 100% open has been proven.
   4. The variable flow chilled water pumping system shall maintain minimum flow for 5-minutes prior to starting the chiller(s).
   5. Enable the lead chiller via hardwired connection.

D. Chiller Staging: Chillers shall be staged on/off based on the actual building tonnage. Building tonnage shall be calculated using the chilled water flow meter and chilled water supply & return temperatures to and from the building.
   1. Building tonnage = (Chilled Water Flow (gpm) X (Tret – Tsup) X 500)/12000
   2. Enabling a Lag Chiller:
      a. Enabling Lag1 Chiller (Option #1): The lag1-chiller shall be enabled when building capacity exceeds 90% of its scheduled capacity.
         1) Provide a 20-minute time delay before enabling the Lag1 chiller, if at anytime during the 20-minute delay building capacity reduces below 90% of rated chiller capacity, the lag1 command shall be cancelled and time delay shall be reset.
      b. Enabling Lag1 Chiller (Option #2): The lag1-chiller shall be enabled when the supply water temperature to the building rises 1.5F above setpoint.

1) Provide a 20-minute time delay before enabling the Lag1 chiller, if at anytime during the 20-minute delay chilled water supply temperature to the building drops below 1.5F from setpoint, the lag1 command shall be cancelled and time delay shall be reset.

c. Enabling Lag2 Chiller (Option #1): The lag2-chiller shall be enabled when building capacity exceeds 90% of the combined scheduled capacity of the two (2) operating chillers.
   1) Provide a 20-minute time delay before enabling the Lag2 chiller, if at anytime during the 20-minute delay building capacity reduces below 90% of the combined chiller capacity, the lag1 command shall be cancelled and time delay shall be reset.

d. Enabling Lag2 Chiller (Option #2): The lag2-chiller shall be enabled when the supply water temperature to the building rise 1.5F above setpoint.
   1) Provide a 20-minute time delay before enabling the Lag2 chiller, if at anytime during the 20-minute delay the chilled water supply temperature drops below 1.5F from setpoint, the lag2 command shall be cancelled and time delay shall be reset.

3. Disabling a Lag Chiller:
   a. Disabling Lag2 Chiller: The lag2 chiller shall be disabled when the building capacity is 55% or less than the combined CP capacity of the 3-operating chillers, i.e. with 3-chillers operating, the central plant capacity is equal to 1,575-ton, the lag2 chiller shall be disabled when building capacity is 866-ton or less.
      1) The lag2 chiller shall be disabled immediately when reaching 55% of combined CP capacity, do not provide a time delay.
   b. Disabling Lag1 Chiller: The lag1 chiller shall be disabled when the building capacity is 40% or less than the combined CP capacity of the 2-operating chillers, i.e. with 2-chillers operating, the central plant capacity is equal to 1,050-ton, the lag1 chiller shall be disabled when building capacity is 420-ton or less.
      1) The lag1 chiller shall be disabled immediately when reaching 40% of combined CP capacity, do not provide a time delay.

E. Sequence for Staging Up (activating a Lag chiller): The following shall occur in sequential order when activating a lag chiller:
   1. Lock chilled water pump(s) speed at current speed.
   2. Lock all air handling units control valves at their current position.
   3. Initiate Lag Condenser Water System start sequence.
   4. The Lag chillers evaporator and condenser 2-way, 2-position control valves shall gradually open over a period of 5 minutes (adj.).
   5. After valve position has been verified by position switch, the lag chiller shall be started. After the chiller has started, a 5-minute delay shall be provided to allow the lag chiller to load, after the delay the following shall occur.
      a. Unlock pump speed. Pump(s) speed shall not be allowed to change more than 5 hz per minute until pump speed setpoint has been achieved.
      b. Unlock chilled water control valves on air handling units. Valve position shall not be allowed to change more than 5% per minute until setpoint has been met.

F. Sequence for Staging down (deactivating a lag chiller): The following shall occur in sequence order when deactivating a lag chiller:
   1. Lock chilled water pump(s) speed at current speed.
   2. Lock chilled water valves on all air-handling units at current position.
   3. Deactivate Lag chiller. After deactivating Lag chiller provide 5-minute delay, after period the following shall occur.
      a. Initiate Lag Condenser Water System stop sequence.

b. Close chilled water isolation valve on deactivated chiller. Valve shall close over a 5-minute period.

4. After the Lag chiller has been disabled and isolation valve has been proven closed the following shall occur.
   a. Unlock pump speed. Pump(s) speed shall not be allowed to change more than 5 hz per minute until pump speed setpoint has been achieved.
   b. Unlock chilled water control valves on air handling units. Valve position shall not be allowed to change more than 5% per minute until setpoint has been met.

G. Primary pumping sequence:
   1. The pumps shall operate on a lead/lag1/lag2 basis. Lead/lag1/lag2 operation shall rotate on a weekly (adjustable) basis. The lead/lag1/lag2/lag3 pumps shall be capable of operating if required by the demand and shall be controlled by multiply system pressure differential sensors.
      a. Provide each pump with a current sensor to verify pump operations. If flow is not proven, the pump shall be deactivated and an alarm shall be displayed at the BAS. In the event chilled water flow fails while the chiller is operating, the back-up chilled water pump shall activate. Once the cause of the alarm has been investigated and repaired, the lead pump shall be placed back into normal operations and the back-up pump shall deactivate. Provide a thirty-second time delay to prevent false alarms.
   2. The system shall be provided with a differential pressure sensor installed in Mechanical Platform **MECH M01**, that shall control pump(s) speed. This sensor shall be “hardwired” to the chiller plant unitary controller.
      a. The contractor shall provide all system components and control wiring necessary for proper system operation.
      b. The chilled water pump controller shall continuously survey the DP sensors. The differential pressure setting shall be set per TAB contractor and be reset per the “Chilled Water Loop Pump Speed Control” sequence.
      c. The system shall start with 1- pumps running. Provide a 15-minute (adj) time delay before a lag pump can be incremented or decremented. Incrementing and decrementing a lag pump shall be as follows.
         1) Incrementing a lag pump:
            (a) A lag pump shall be started when pump(s) speed reaches 95%. Provide a 15-minute delay before allowing a pump to increment.
         2) Decrementing a lag pump: Decrementing a lag pump shall vary depending on the number of pumps operating. Provide a 15-minute (adj) time delay when decrementing a lag pump.
            (a) Decrementing lag2 pump (three (3) pumps operating): On decrease to 95% pump speed, decrement the lag2.
            (b) Decrementing lag1 pump (two (2) pumps operating): On decrease to 70% pump speed, decrement lag1 pump.
         3) Lead pump(s) speed control during the decrement/increment process: The lead pump(s) speed during the incrementing process speed shall be allowed to modulate as required to maintain system DP.
         4) Decremented pump speed control: The decremented pump speed shall not be allowed to decrease by more than 5 hz per minute and shall shut off when pump speed reaches 20% (12 hz).
         5) Pump(s) speed shall not be allowed to change by more than 5 hz per minute during the Increment/Decrement process.
         6) Additional requirements while decrementing or incrementing a pump.
            (a) All AHU chilled water valves shall be locked in position for a minimum of 5 minutes during the Increment/Decrement process.

H. Chiller Minimum Flow Requirements

1. The bypass valve shall be located in the Gym Mechanical platform **MECH EP01** and shall modulate as required to maintain a minimum flow through the chillers as follows.
   a. Lead Chiller Operating = 600 gpm
   b. Lead + Lag1 Operating = 1,200 gpm
   c. Lead + Lag1 + Lag 2 Operating = 1,800 gpm
2. The bypass shall be set to open quickly as pressures reaches minimum operation pressure. The valves closure speed shall be greatly slowed, and shall have a maximum closure speed of 5% per minute.
3. One chilled water bypass valve shall be provided. The valve shall be sized for a 15ft pressure loss at 850 gpm.

I. Chiller Maximum Flow Requirements
1. The chiller shall not be allowed to exceed its maximum flow rate. In the event that a chiller approaches 85% of its maximum flow rate, an additional chiller shall be started. Refer to chiller staging requirements in this section for chiller staging sequencing.

J. Operator Station Display: Indicate the following on operator workstation display terminal:
1. DDC system graphic.
2. DDC system status, on-off.
3. Outdoor-air temperature.
4. System flow to from flow meter installed in Central Plant.
5. Chilled-water pump(s) on-off status.
6. Chilled-water pump(s) speed.
7. Chilled-water supply/return temperature to building.
8. Chilled-water return temperature to chillers (downstream of bypass valve).
9. Bypass valve position.
10. Chiller supply water temperature for each chiller.
11. Chiller(s) status.
12. System capacity in tons (based flow meter reading and supply and return temperatures).
13. Differential pressure for each chiller.
14. Link to each trend required per “1.07 Chilled and Condenser Water Trends” of this section.

K. Chilled Water Loop Pump Speed Control: Pump(s) speed shall modulate as required to maintain the system differential pressure. The system DP shall be reset based on valve position at the AHU’s.
1. DP Settings:
   a. Maximum DP Setting = 15 PSI (adj)
   b. Minimum DP Setting = 8 PSI (adj)
2. DP reset sequence:
   a. Poll valve position of all units on a 5-minute basis with the following exceptions.
      1) Units to be excluded from the polling process are:
         (a) All fan coil units.
         (b) All dedicated OA units (not including lab units)
   b. Pump(s) speed shall modulate as required to maintain an average open position 95% (adj) of the 3 Units with the most open valve position.
3. On system start-up DP shall be set to the at the midpoint between the min. and max. DP settings. The DP setpoint shall remain at the midpoint for a minimum of 15-minutes (adj) before the DP can be reset up or down.

1.07 CONDENSER WATER SYSTEM SEQUENCE

A. General: The system is design to operate all three (3) cooling tower cells when only one (1) chiller is operating. The system contains the following components:
1. Three (3) 525-ton cell cooling towers (CT-1A, 1B & 1C)
2. Three condenser water pumps (CWP-1A, 1B & 1C) piped in a header arrangement.

3. 2-position control valve at tower inlet and outlet.
4. VFD for each cooling tower fan.
5. Tower bypass valves for condenser water loop temperature control.
6. Chiller condenser water isolation valves.
7. Chiller head pressure control valve (Carrier only).
8. The towers shall be either automatically started/stopped by the DDC controls system or manually started/stopped by the system operator through the condenser water web page.
    a. Automatic Mode: When operating in the automatic mode, all three tower cells shall be operational with associated automatic isolation valves open.
    b. Manual Mode: When operating in the manual mode, the user shall select the individual cell(s) to operate, when selected to operate, the automatic isolation valves shall be open.

B. Determining Number of Cooling Towers to Operate:
    1. Automatic Mode: On start-up, the all three cooling towers shall start, (note, the cooling towers are designed and size to allow all three (3) cooling towers to operate when only one (1) chiller and one (1) condenser water pump is operating). When operating in the automatic mode, each towers automatic control valves (inlet and outlet) shall be open.
        a. The automatic control valves at the tower inlet and outlet shall be normally open.
    2. Manual Mode: Provide a manual mode to allow the operator to select the specific tower or combination of towers to operate. When an individual tower is isolated or not operating, it's individual inlet and outlet control valve shall be closed.

C. On chiller start-up, the following shall occur in sequential order:
    1. When starting up a chiller, the following shall occur at the same time. Once the following conditions have been met, the chiller shall be allowed to operate.
        a. The condenser water isolation control valve on the chiller shall gradually open over a 5-minute period.
        b. The condenser water pumps shall start and gradually increase to full speed over a 5-minute period.
    2. After the 5-minute period the chiller shall start and the cooling tower fans shall be allowed to operate as required to maintain discharge temperature setpoint. The chiller and tower fans shall not be allowed to operate unless valves are proved open.

D. Staging up a lag chiller: The following shall occur at the same time.
    1. Activate a lag condenser water pump. The lag condenser pumps VFD shall gradually increase speed from start to design frequence over a 5-minute period.
        a. The condenser water pumps shall operate in a Lead/Lag1/Lag2 arrangement with the lead pump rotating on a weekly basis. The number of condenswer water pumps operating shall match the number of chillers operating.
    2. The condenser water control valve on the lag chiller shall gradually open over a 5-minute period.

E. Staging down chillers:
    1. When staging down a chillers, the following shall occur sequential.
        a. Disable lag chiller, after a period of 5-minutes, proceed to next step.
        b. After the chiller has been disabled, the following shall occur over a 5-minute period at the same time:
            1) Close lag chiller’s condenser water control valve (Over a 5-minute period)
            2) Disable a lag condenser water pump by reducing the speed to 0 HZ (over a 5-minute period).
    2. When shutting down condenser water system.

a. The condenser water system shall operate for a period of 5-minutes after the chillers have been disabled. After that period, the operating towers and condenser water pumps shall stop and all valves shall close
b. Disable operating chillers, after a period of 5-minutes, proceed to next step.
    1) Decrease speed of lag condenser water pump to its minimum speed over a 5-minute period then disable the pump.

F. Condenser Water Temperature Control: Condenser water temperature control shall be accomplished by modulating the tower fan(s) speed and tower bypass control valves. Provide temperature sensor in common CWS to chillers. When multiple fans are operating, all towers fans shall operate at the same fan speed. Condenser water temperature shall be maintained as follows:
1. Tower Fan Control: Cooling tower fans shall modulate as required to maintain a CWS temp to the chillers that is 5°F above the outdoor wet bulb temperature with a maximum CWS temperature of 86°F and a minimum temperature of 65°F.
2. Cooling Tower Bypass Control: Bypass valves are being provided in the return to the cooling towers. Provide individual modulating control valves in the return and bypass line as indicated on the piping schematic. The bypass valves shall be electronically locked to moduate at the same rate. Modulate bypass valves as requried to maintain a minimum supply water temperature to the cooling tower of 60°F (adj).

G. Pump Speed Control:
1. Pump speed shall be constant, the number of pumps operating shall match the number of chillers operating.

H. Vibration Isolation Cut-out Oil Level Swith:
1. Monitor vibration cut-out switch and alarm when activated.
2. Monitor manufacturer oil-level switch and alarm when low.

I. Cooling Tower Make-up and Blow-down:
1. Provide two (2) electronic water meters to monitor and log cooling tower water consumption and chemical treatment blowdown. Meter will provide total gallons of water used to date. Controls shall store milestone gallon usage, (i.e. Jan 1st, 1st day of month and 1st day of week) and use to calculate water usage as indicated in display points below. Meters shall be installed at the following locations:
    a. Tower fill
    b. Chemical treatment blow-down.

J. Operator Station Display: Provide graphic web page showing condenser water piping schematic, control valves and equipment. The following information shall be displayed on the web page:
1. Overall system status
2. C-1A, 1B & 1C status (on/off/alarm)
3. CWP-1A, 1B & 1C status (on/off/alarm)
4. CWP-1A, 1B & 1C speeds
5. Cooling tower fan(s) status (on/off/alarm)
6. Cooling tower fan(s) speed
7. Cooling tower control valve status (open/closed/alarm)
8. Chiller control valves status (open/closed/alarm)
9. Condenser water temperature setpoint
10. Condenser water supply temp to chiller(s) (located in common pipe serving chillers)
11. Condenser water return temp from C-1A, 1B & 1C (provide individual return water temperature sensors).
12. C-1A, 1B & 1C individual DP, (note, DP measured will be low, the range of this DP sensor shall be from 0 to 10 psi).

13. Gallons of tower make-up water used displayed as the following:
    a. Week to date
    b. Month to date
    c. Year to date
    d. Previous Week
    e. Previous Month
    f. Pervious Year
14. Gallons of tower blow-down displayed as the following:
    a. Week to date
    b. Month to date
    c. Year to date
    d. Previous Week
    e. Previous Month
    f. Pervious Year
15. Tower make-up water alarm if water use has increased by more than 20% from previous week.
16. Vibration Cut-out Switch Status
17. Oil Level Level.
18. Condenser water trend data as indicated in this specification.
19. Link to required condenser water trends.

1.08 CHILLED AND CONDENSER WATER TREND REQUIREMENTS

A. Provide the following diagnostic trend logs for the chilled and condenser water system.
   1. Chiller DP Trend: Points shall be trended on 5-minute intervals.
      a. C-1A Evaporator DP (FT of Head)
      b. C-1A Condenser DP (FT of Head)
      c. C-1B Evaporator DP (FT of Head)
      d. C-1B Condenser DP (FT of Head)
      e. C-1C Evaporator DP (FT of Head)
      f. C-1C Condenser DP (FT of Head)
      g. Bypass valve position
   2. Individual Chiller Trends: Provide for each individual chiller. The trend points shall be recorded on a 5-minute basis
      a. Chiller Status (on/off/alarm)
      b. Chilled water supply temp
      c. Chilled water return temp (temp in common return manifold)
      d. Condenser water supply temp (temp in common supply manifold)
      e. Condenser water return temp
      f. Condenser water isolation valve position
      g. Chilled water isolation valve position
      h. Head pressure control valve position
      i. Evaporator barrel DP (FT of head)
      j. Condenser DP (FT of head)
   3. Overall Chilled Water Systems Temperature Trend: Points shall be trended on 5-minute intervals.
      a. Chiller Status for each chiller (on/off/alarm)
      b. Return water temperature (down stream of bypass)
      c. C-1A supply water temperature
      d. C-1B supply water temperature
      e. C-1C supply water temperature

4. Overall Condenser water system temperature trend: Points shall be trended on 5-minute intervals.
    a. Condenser water supply temp (from tower to chillers)
    b. Condenser water return temp to tower (combined from three chillers)
    c. Cooling Tower Status for each cell.
5. Overall cooling tower trend: Points shall be trended on 5-minute intervals.
    a. Cooling tower fan #1 status (on/off/alarm)
    b. Cooling tower fan #2 status (on/off/alarm)
    c. Cooling tower fan #3 status (on/off/alarm)
    d. Cooling tower fan #1 speed
    e. Cooling tower fan #2 speed
    f. Cooling tower fan #3 speed
    g. Bypass valve positions
6. Chilled Water System Pump Trends: Points shall be trended on 5-minute intervals.
    a. CHWP-1A Status (on/off/alarm)
    b. CHWP-1B Status (on/off/alarm)
    c. CHWP-1C Status (on/off/alarm)
    d. CHWP-1A Speed
    e. CHWP-1B Speed
    f. CHWP-1C Speed
7. Condenser water system pump trends: Points shall be trended on 5-minute intervals.
    a. CWP-1A Status (on/off/alarm)
    b. CWP-1B Status (on/off/alarm)
    c. CWP-1C Status (on/off/alarm)

1.09 HOT WATER HEATING SYSTEM CONTROL

A. General: The hot water heating system shall consist of heating hot water boiler(s), associated primary heating hot water pump(s) with variable speed drives and isolation control valves.
    1. The heating hot water system shall be started and stopped through the BAS system.
    2. The boiler is being provided with a factory controller that will control discharge water temperature and operation of the primary heating hot water pump(s). Refer to specification section 235216 Condensing Boilers for additional information.
    3. Install the following boiler manufacture provided sensors.
        a. Boiler OA temperature sensor(s) provided by boiler manufacture.
        b. Install CO gas sensor provided by boiler manufacture.

B. Hot Water System Operations: The heating hot water system shall operate under the following conditions:
    1. An individual air handling unit is calling for heat or dehumidification.
    2. A minimum of 10% (adj) of terminal boxes with hydronic heating coils are calling for heat.

C. Heating Hot Water System Sequencing:
    1. Activation: When called to operate by the BAS, the following shall occur.
        a. The boilers isolation valve shall open over a 5-minute period. Provide valves with position switches to confrim
        b. The BAS system shall send boiler start signal to boiler manufacture provided control panel.
            1) The boiler control system shall control the operation of the boiler(s) and associated primary hot water pump(s).
    2. Deactivation: When called to deactivate by the BAS, the following shall occur.
        a. The secondary hot water pump(s) shall operate for a minimum of 300 seconds.
    3. Primary Pump Sequencing: The boiler(s) control panel shall determine when to operate a boiler's individual primary hot water pump.

a. Provide current transducers to determine status of primary hot water pumps.

D. Hot Water Pump Control:
1. The pumps shall operate in a lead/lag sequenece with pump rotations as required to keep equal ware on the pumps.
2. The pump controller shall survey the DP sensor and adjust speed as required to satisfy setpoint. The DP sensor must be connected to the controller that is controlling the hot water pumps.

E. Bypass Valve Control:
1. Install flow meter in the heating hot water pipe. This flow meter shall be used to control system bypass valve and maintain the minimum flow requried for boiler operation.
2. Install bypass where indicated on plans, modulate bypass valve as required to maintain minimum boiler flow.
a. The bypass valve must be tied directly into the central plant controller, mapping of this point through other controllers is not allowed.

F. Operator Station Display: Provide graphic web page showing hot water piping schematic. The following information shall be displayed on the web page:
1. Overall system status
2. Hot water supply temperature
3. Hot water return temperature
4. HWS flow (gpm)
5. Heating hot water pump(s) status
6. DP Measured
7. Points obtainable from boiler BACnet card.

G. Diagnostic Trend Logs: The following trends shall be set-up and accessible from the hot water system web page.
1. Trend #1: Hot Water Heating General Data
a. System status
b. HWS Temp
c. HWR Temp
d. HWS Flow (gpm)
e. Building BTU's (calculated by using flow at flow meter and HWS/R temperature)
2. Trend #2: Pump Trend
a. Lead pump speed
b. Primary pump(s) stat
c. Building DP
d. HWS GPM
3. Trend #3: Hot Water Control Valve Trend
a. Trend valve position for all heating hot waver valves as a percentage of full open.

1.10 VAV AIR HANDLING UNITS

A. General: Unit shall consist of supply fan with VFD and chilled water coil with modulating 2-way control valve.

B. Supply Air Fan:
1. Provide differential air pressure sensor to prove fan status.
2. The supply air fan shall be controlled through a variable frequency drive (VFD).
3. Provide and install duct mounted pressure sensor approximately 2/3 way down the supply duct main, (if not indicated on drawings, confirm location with engineer prior to installing sensor). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.

4. Differential pressure optimization shall be accomplished by polling all VAV box damper positions on a 5-minute basis (adj) and resetting the DP setpoint so that at minimum of 10% of terminal boxes are 90% open.
    a. Program shall be able to exclude an individual terminal box from the polling process.
5. The adjustable reset range will be from 0.5” wg to 1.25” wg, (the range shall be adjustable from the AHU web page).
6. SAF Start-up: Before starting the supply air fan, all terminal boxes associated with the air handling unit shall modulate open to their minimum damper position. Provide a minimum 1-minute delay before starting SAF to ensure all terminal box dampers are at their minimum position.
7. If less than 25% (adj) of associated terminal box air valves are completely closed, the air handling unit shall stop. If more than 25% (adj) of FVAV air valves are open, the air handling unit shall start.

C. Supply Air Temperature Control: Supply air temperature control shall be accomplished by modulating the units chilled water control valve. The specific discharge air temperature as measured in supply air duct shall be dependent on a combination of the average temperature of the individual zones and/or return air dewpoint temperature.
    1. Average Space Temperature: Each terminal box space temperature shall be polled at 5-minute intervals to determine the average difference between space temperature and space temperature setpoint.
    2. Return Air Dewpoint (DPT): Provide dewpoint senor located in RA duct upstream of the units OA connection (if provided with OA). The unit’s initial DPT setpoint shall be 55F (adj).
    3. Discharge Temperature Setpoint:
        a. Discharge temperature setpoint, when return air DPT is at or below setpoint, shall be based on the average space temperature as indicated below.
            1) Average space temperature 1°F above setpoint: Discharge air temperature 55°F (adj).
            2) Average space temperature 1°F below setpoint: Discharge air temperature 62°F (adj).
            3) Space temperature between dead band: Vary linearly.
        b. Discharge temperature setpoint when return air DPT is above set point shall be as follows:
            1) Return Air DPT below or at setpoint: Discharge air temperature programed setpoint based on average space temperature above.
            2) Return Air DPT 1.5°F above setpoint: Discharge air temperature 55°F (adj).
            3) DPT between dead band: Vary linearly.

D. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relays and contacts as required to control lights so that lights are on only when the supply air fan is operating.

E. Display Points:
    1. DDC system web page
    2. Fan status (on/off/failure to run)
    3. Duct static pressure
    4. Duct static pressure setpoint
    5. Average space temperature setpoint differential
    6. Supply fan speed (% of full speed not HZ)
    7. Discharge air temperature
    8. Discharge air temperature setpoint
    9. Return air DPT.

10. Return air temperature (mount adjacent to DP sensor in ductwork away from OA connection).
11. Mixed air temperature.
12. Coiling-coil control valve % of full open (software point, not actual measured)
13. CHWR water temperature

F. Diagnostic Trends: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. VAV AHU Trend #1: To be trended on change of state
      a. AHU Run Command
      b. Fan status
   2. VAV AHU Trend #2: (To be trended on a 5-minute basis)
      a. Fan speed (Percentage of max not HZ)
      b. Duct static pressure
      c. Average position of connected terminal box air valves
      d. Average space temperature setpoint difference
      e. Discharge air temperature
      f. Discharge air temperature setpoint
      g. Return air DP temperature
   3. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Discharge air temperature
      b. Discharge air temperature setpoint
      c. Return air temperature
      d. Return air DP temperature
      e. Control valve % opened
      f. Chilled water coil return water temperature
   4. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.11 SINGLE ZONE VARIABLE SPEED AIR HANLDING UNIT

A. General: Unit shall consist of supply fan with VFD, chilled water coil with modulating 2-way control valve and re-heat coil with modulating 2-way control valve. Space temperature setpoint shall be input through the unit's web page, a minimum of 4°F offset shall be provided between the heating and cooling setpoints.

B. Space Temperature Sensor Types: Combination temperature and humidity.

C. Supply Air Fan:
   1. Provide differential air pressure sensor to prove fan status.
   2. The supply air fan shall be controlled through a wall-mounted variable frequency drive (VFD).
   3. A space mounted temperature sensor(s) shall control the speed of the supply air fan. The maximum airflow shall be set by the TAB with minimum airflow being 30% (adj) of the maximum airflow.
      a. When multiple space mounted temperature sensors are indicated on the plans, an average temperature shall be determined from the sensors.

D. Space Temperature Control: A wall mounted temperature sensor(s) shall maintain space temperature by modulating the units SAF and control valves as follows.
   1. Supply Air Fan Control: The supply air fan shall modulate based on space temperature, a 2°F (adjustable) dead band shall be utilized to control the fans speed for both heating and cooling systems as follows
      a. Cooling Mode:

1) Space temperature 1°F below setpoint: Supply fan shall be at minimum speed.
2) Space temperature 1°F above setpoint: Supply fan shall be at maximum speed.
3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.

b. Heating Mode:
1) Space temperature 1°F below setpoint: Supply fan shall be at maximum speed.
2) Space temperature 1°F above setpoint: Supply fan shall be at minimum speed.
3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.

c. When space temperatures are between the cooling and heating dead band range, the supply fans shall be at its minimum setpoint.

2. Chilled Water and Reheat Coil Control: The control valves shall modulate based on space temperature, a 2°F (adjustable) deadband shall be utilized to control to a specific discharge air temperature.
a. Chilled Water Coil Control Valve:
1) Space temperature 1°F below setpoint: Discharge air temperature 62°F (adj).
2) Space temperature 1°F above setpoint: Discharge air temperature 55°F (adj).
3) Space temperature between limits: Vary linearly.

b. Hot Water Reheat Coil Control Valve:
1) Space temperature 1°F below setpoint: Discharge air temperature 85°F (adj).
2) Space temperature 1°F above setpoint: Discharge air temperature 72°F (adj).
3) Space temperature between limits: Vary linearly.

c. When space temperatures are between the cooling and heating dead band range, both cooling and heating control valves shall be closed.

3. Dehumidification Mode:
a. The unit shall enter dehumidification mode if space humidity levels rise above setpoint of 55% RH (adj). There shall be three (3) different stages of dehumidification.
1) Stage 1 dehumidification (between setpoint and 2% RH above):
(a) CWC control valve shall modulate to maintain a maximum discharge air temperature of 57F.
2) Stage 2 dehumidification (2-4% RH above setpoint):
(a) CWC control valve shall modulate to maintain a discharge air temperature of 55F.
3) Stage 3 dehumidification (4% RH above setpoint): Before entering Stage 3 dehumidification, space temperatures must be less than or equal to the space setpoint and the heating hot water system must be proven operational, (i.e. boiler and hot water pump(s) active with HWS temp above 100F). If these conditions are not met, the unit shall remain at Stage 2 dehumidification. If these conditions are met, the following shall occur. The unit shall remain in Stage 3 dehumidification until space humidity levels drop to entering Stage 2 conditions, (2% above setpoint).
(a) Leaving air temperature from CWC (this is different than the units discharge air temperature) shall be set to 53F (adj).
(b) The fan speed shall be set to 75% of maximum speed.
(c) The reheat coil shall modulate as required to maintain space temperature setpoint.

E. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relay's and contacts as required to control UV lights so that the equipment is on only when the supply air fan is operating.

F. OA Damper and Relief Air Control: Specific units are provided with seperate OA connection to unconditioned air and relief air fan.
1. Units containing OA dampers and Relief air fans are AHU 10.1, 10.2 (any others?)

2. Units shall be provided with the following:
    a. Space mounted CO2 sensor (install protective cover in gyms).
    b. Modulating OA damper.
    c. VFD for relief air fan.
    d. 2-position relief air damper.
3. OA damper shall modulate based on space CO2 levels as follows all points shall be adjustable from the graphics front-end:
    a. Space CO2 level 550 PPM or less: OA damper shall be closed
    b. Space CO2 level 1100 PPM or greater: OA damper shall be 100% opened
    c. Space CO2 level between 550 & 1100 PPM: Vary Linearly
4. The relief air fan's VFD shall be controlled based on the damper position of the OA damper as follows, all points shall be adjustable from the graphics front-end:
    a. OA damper position less than 15% open: Relief air fan shall be off.
    b. OA damper position 15% open: Relief air fan shall be at minimum speed (assume to be 20 hz) and associated damper shall be open.
    c. OA damper position 100% open: Relief air fan shall be at maximum speed (speed to be set by the TAB contractor).
    d. OA damper position between 15% open and 100% open: Vary lineraly.
    e. When the Relief air fan is on, it's associated 2-position damper shall be open.

G. Display Points:
1. DDC system web page
2. Space temperature (if more than one sensor is present show temperature for each sensor and the average temperature)
3. Space humidity level
4. Fan status (on/off/failure to run)
5. Supply fan speed (% of full speed)
6. Discharge air temperature
7. Discharge air temperature setpoint
8. Return air temperature
9. Coiling-coil control valve % of full open (software point, not actual measured)
10. Heating-coil control valve % of full open (software point, not actual measured)
11. Chilled water coil return water temperature
12. Dehumidification mode status
13. OA Damper & Relief Air Control: Required only on select units
    a. Space CO2 Level
    b. OA damper position
    c. Relief fan status
    d. Relief fan speed
    e. Relief damper position

H. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit’s system web page.
1. Trend #1:
    a. Fan status
    b. Fan speed
    c. Average space temperature
    d. Space relative humidity
    e. Space CO2 level (
    f. OA damper position (applicable units only)
    g. Relief fan speed (applicable units only)
2. Trend #2

a. Discharge air temperature
b. Discharge air temperature set-point
c. Return air temperature (between OA damper connection and inlet of unit)
d. Cooling coil control valve % open
e. Heating coil control valve % open
f. Chilled water coil return water temperature

1.12 DEDICATED OUTSIDE AIR UNIT (DOAU) WITH ENERGY RECOVERY WHEEL

A. General: Units consist of supply fan(s) with VFD, exhaust fan(s) with VFD, enthalpy wheel with bypass damper, face & bypass damper, chilled water coil with 2-way modulating control valve, hot water coil with 2-way modulating control valve, 2-way 2-position damper at connection to OA louver and 2-way 2-position at connection to EA damper.
   1. Occupied Mode: The air handling unit shall be placed into operation by the BAS based upon user defined schedule.
   2. Unoccupied Mode: During the unoccupied mode, the supply air fan shall de-activate, exhaust fan de-activate, energy recovery wheel shall de-activate and outside air/exhaust air dampers close.

B. Supply Fan Speed Control:
   1. Before supply fan start, 2-way 2-position OA damper shall open.
   2. A differential air pressure sensor shall prove fan status.
   3. The supply air fan shall be controlled through a unit-mounted variable frequency drive (VFD).
   4. Provide and install a duct mounted pressure sensors 3/4 of the distance out in the system, (field verify location with engineer). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.
   5. Differential pressure optimization shall be accomplished by polling all VAV box damper positions and resetting the DP set-point so that at least one VAV damper is 95% open.
   6. The adjustable reset range will be from 0.3” wg to 1.25” wg.

C. Exhaust Fan Speed Control:
   1. Before exhaust fan start, 2-way 2-position EA damper shall open.
   2. Modulate exhaust fans VFD at same percentages as supply fan.

D. Toilet Room Exhaust Control:
   1. General: Two main exhaust trunks are routed directly back to the OA unit, a constant flow Toilet Room Exhaust trunk and a Variable Flow Exhaust trunk.
      a. Toilet Room Exhaust: Provide DP pressure sensor located at manual balancing damper as indicated on drawings. This sensor shall be used to modulate the control damper in the “Variable Flow Exhaust” trunk.
      b. Variable Flow Exhaust Trunk: Provide modulating control damper at location indicated on drawings. This damper shall modulate as required to maintain a constant static pressure drop over manual balancing damper installed in “Toilet Room Exhaust Trunk”. The pressure loss value shall be field calibrated with T&B contractor.

E. Discharge Air Temperature Controls:
   1. A duct mounted discharge air temperature sensor shall control the units face & bypass (F&B) dampers, 2-way chilled water control valve and 2-way hot water valve.
      a. General requirements:
         1) Provide temperature sensor at chilled water coil serpentine across the entire face of the water coil every six inches on center. This temp sensor shall control the operation of the coils control valve.
         2) Provide duct mounted temperature sensor to control the operation of the units F&B damper.

b. When outdoor air temperature is above 75F (adj):
   1) The energy recovery wheel shall operate, (wheel bypass damper shall be closed).
   2) Chilled water valve control: Control of the chilled water control valve shall be dependant on the poisition of the F&B damper. Provide a 5% deadband as follows:
      (a) F&B damper open more than 10% to the chilled water coil the control valve: Modulate as required to maintain a 55F leaving coil temperature.
      (b) F&B damper less than 10% to the chilled water coil: Chilled water valve shall close and remain close until F&B damper is more than 15% open to the coil.
   3) Face and bypass damper shall modulate as required to maintain 65F (adj) discharge air temperature.
   4) Dehumidification Mode: In the event that dewpoint (DPT) in the variable flow exhaust duct from the building rises to 55F (adj), the discharge air temperature shall be reset as follows:
      (a) DPT temperature 1.5F above DP setpoint = 57F (adj) Discharge air temp
      (b) DPT temperature at DPT setpoint = 65F (adj) Discharge air temp
      (c) Between 1.5F above & setpoint (55DPT) = Vary linearly between 57F & 65F.

c. When outdoor air temperature is between 75 degrees F (adj.) and 60 degrees F (adj.).
   1) The energy recovery wheel shall not operate and its associated bypass damper shall be open.
   2) Chilled water valve control: Control of the chilled water control valve shall be dependant on the poisition of the F&B damper. Provide a 5% deadband as follows
      (a) F&B damper open more than 10% to the chilled water coil the control valve: Modulate as required to maintain a 55F leaving coil temperature.
      (b) F&B damper less than 10% to the chilled water coil: Chilled water valve shall close and remain close until F&B damper is more than 15% open to the coil.
   3) The face and bypass damper shall modulate as required to maintain discharge air temperature.
   4) Dehumidification Mode: Dehumidification mode shall match sequence for when OA temps are above 75F

d. When the outdoor air temperature is below 60°F.
   1) The energy recovery wheel shall operate and the wheels bypass damper shall be closed.
   2) The face and bypass damper shall be in full face mode, (all airflow through the heating coil).
   3) The 2-way hot water control valve shall modulate as required to maintain 65F (adj) discharge air temperature.

F. System Start-up: When a unit has been called to start-up by the BAS, the following shall occur in sequential order:
   1. The units control valve shall open to a minimum position of 50% (adj) or as required to achieve discharge air temperature (whichever is greater) for a minimum period of 15 minutes (adj).
   2. The supply fan shall activate and operate under its normal sequence.
   3. After the start-up period, the valve shall return to its normal operating mode.

a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) when switch back from Morning Cool-down Mode to normal operations mode.

G. System Shut-down: When a unit has been called to shut-down by the BAS, the following shall occur in sequential order:
1. The units 2-way control valve shall lock in its current position while SA & EA fans are deactivated.
2. The SA and EA fans speed shall be reduced to its minimum setting over a period of 5 minutes (adj).
3. Once SA & EA fans have reached their minimum set-point, the SA and EA fans shall be deactivated.
4. After SA & EA fans have been deactivated, the units chilled water control valve shall close.
   a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) during System Shut-down mode.

H. Freeze Protection:
1. Freeze protection wire shall be serpentine across the entire face of the water coil every six inches on center.
   a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
   b. If a temperature of 40 degrees F (adj.), or less is detected, then the supply air and exhaust air fans shall stop, outside air and exhaust air dampers shall fully close, the hot water control valve shall go full open and an audio/visual alarm shall activate through the BAS.
   c. Upon correction of the problem, the system shall be reset and shall return to normal operation.

I. Temperature Indication: Provide air temperature indication in the supply and return ducts and entering/leaving air temperature to each water coil.

J. UV Disinfection: The UV Disinfection system shall be on when unit is active, provide relays and contactors as required to control manufactured supplied UV lights.

K. Operator Station Display: Indicate the following on operator workstation display terminal:
1. DDC system graphic.
2. DDC system on-off indication.
3. DDC system occupied/unoccupied mode.
4. Outdoor-air-temperature indication.
5. Outdoor humidity indication (measured at inlet OA duct)
6. Outdoor CO2 ppm level, (obtain from FMS).
7. Enthalpy wheel status, (on/off/failure to start).
8. Enthalpy wheel inlet exhaust temperature
9. Enthalpy wheel outlet exhaust temperature
10. Enthalpy wheel inlet supply temperature
11. Enthalpy wheel outlet supply temperature
12. Enthalpy wheel bypass damper position
13. Supply-fan on-off indication, (on/off/failure to start).
14. Supply-fan-discharge static-pressure indication.
15. Supply-fan-discharge static-pressure set point.
16. Supply-fan airflow rate.
17. Supply-fan speed.
18. Exhaust-fan on-off indication, (on/off/failure to start).
19. Exhaust-fan-discharge static-pressure indication.

20. Exhaust-fan-discharge static-pressure set point.
21. Exhaust-fan airflow rate.
22. Exhaust-fan speed.
23. Face & bypass damper status.
24. Face & bypass damper position.
25. Relative humidity indication, (EA inlet duct and OA outlet duct).
26. Supply filter air-pressure-drop indication.
27. Supply filter low-air-pressure set point.
28. Supply filter high-air-pressure set point.
29. Exhaust filter air-pressure-drop indication.
30. Exhaust filter low-air-pressure set point.
31. Exhaust filter high-air-pressure set point.
32. OA-discharge air-temperature indication, (from sensor mounted in discharge duct).
33. OA-discharge air-temperature set point, (from sensor mounted in discharge duct).
34. Cooling-coil air-temperature indication.
35. Cooling-coil air-temperature set point.
36. Cooling-coil control-valve position (calculated not measured).
37. Chilled water return temperature.
38. Heating-coil air-temperature indication.
39. Heating-coil air-temperature set point.
40. Heating-coil control-valve position (calculated not measured).
41. Freeze stat status.
42. UV Disinfection Status.

L. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. DOAU Trend #1: (To be trended on a 5-minute basis)
      a. SA fan speed
      b. Energy wheel status
      c. DPT
      d. Discharge air temperature setpoint
      e. Discharge air temperature
      f. Face & Bypass Damper Position
      g. CHWR temperature
   2. DOAU Trend #2: (To be trended on a 5-minute basis)
      a. Supply duct static pressure
      b. Toilet exhaust static pressure
      c. General exhaust duct damper position
   3. DOAU Trend #3
      a. Chilled Control valve % opened
      b. Hot Control valve % opened
      c. Face & Bypass Damper Position
      d. Chilled water return water temperature
   4. VAV AHU Trend #3: (To be trended on a 5-minute basis)
      a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.13 CONSTANT VOLUME LAB AIR HANDLING UNIT WITH ENERGY RECOVERY WHEEL & HEAT PIPE

A. General: Unit is a constant volume that provides both conditioning and make-up air to lab spaces. Note the lab spaces require 1.0 cfm EA per sqft, the required cooling airflow is signifiantly less than the amount of code required exhausts, therefore the unit layout and configuration is designed to reduce the amount of reheat required to maintain space temperatures. The unit consit of the following components:
   1. Supply & Exhaust Fan(s) with VFD
   2. Enthalpy wheel with bypass damper around wheel.
   3. Enthalpy wheel bypass damper between EA and OA sections (for morning warm-up/cool down).
   4. Chilled water coil with 2-way modulating control valve
   5. Hot water coil with 2-way modulating control valve
   6. Wrap-around heat pipe for four (4) stages
   7. 2-way 2-position damper at connection to OA intake
   8. 2-way 2-position at connection to EA duct at discharge.

B. Modes of Operation
   1. Occupied Mode: The air handling unit shall be placed into operation by the BAS based upon user defined schedule.
      a. Energy Recovery Wheel: Energy recovery wheel shall be under normal control
      b. Energy Recovery Wheel Bypass Damper Between OA & EA streams: Damper shall be closed.
   2. Unoccupied Mode: While in morning start-up mode air shall be directly circuilated from the space through the unit and back to the space.
      a. Energy Recovery Wheel: Energy recovery wheel shall be off
      b. Energy Recovery Wheel Bypass Damper Between OA & EA streams: Damper shall be open allowing recirculation of air to and from the space it conditions.
      c. OA and EA Discharge Dampers: Closed.
   3. Morning Start-up: While in morning start-up mode air shall be directly circuilated from the space through the unit and back to the space.
      a. Energy Recovery Wheel: Energy recovery wheel shall be off
      b. Energy Recovery Wheel Bypass Damper Between OA & EA Streams: Bypass damper shall be open allowing recirculation of air to and from the space it conditions.
      c. OA and EA Discharge Dampers: Closed.

C. Supply Fan Speed Control:
   1. Before supply fan start, 2-way 2-position OA damper shall open.
   2. A differential air pressure sensor shall prove fan status.
   3. The supply air fan shall be controlled through a unit-mounted variable frequency drive (VFD).
   4. Provide and install a duct mounted pressure sensors 3/4 of the distance out in the system, (field verify location with engineer). The pressure sensors shall control the operation of the supply fan VFD and shall utilize differential pressure optimization.
   5. Differential pressure optimization shall be accomplished by polling all VAV box damper positions and resetting the DP set-point so that at least one VAV damper is 95% open.
   6. The adjustable reset range will be from 0.3” wg to 1.25” wg.

D. Exhaust Fan Speed Control:
   1. Before exhaust fan start, 2-way 2-position EA damper shall open.
   2. The exhaust speed shall be set by TAB contractor and shall operate at a constant speed.

E. Hot and Chilled Water Control Valve Control: Under normal operating conditions, the hot and chilled water control valves shall not be open at the same time. The only exception to this rule is when a freeze stat is tripped.
   1. Hot Water Coil Control: The control valves shall modulate in response to the average space temperature. The BAS system shall poll each individual space on a 5-minute basis to determine the average space temperature. A 2°F average space temperature deadband shall be used, discharge air temperature shall be determined as follows:
      a. Averge Space temperature 1°F below heating setpoint: Heating coil discharge air temperature 70°F (adj).
      b. Average Space temperature 1°F above heating setpoint: Heating coil discharge air temperature 60°F (adj).
      c. Space temperature between limits: Vary linearly.
   2. Chilled Water Coil Control: The control valves shall modulate in response to the average space temperature. The BAS system shall poll each individual space on a 5-minute basis to determine the average space temperature. A 4°F average space temperature deadband shall be used as follows: Discharge air temperature shall be determined as follows:
      a. Averge Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 65°F (adj).
      b. Average Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
      c. Space temperature between limits: Vary linearly.

F. Wrap-Around-Heat Pipe Coil Control: The heat pipe shall be available for reheat only when the entering air temperature to the inlet side of the upstream heat pipe coil is 5°F (adj) greater than the discharge air temperature from the chilled water coil, if this condition is not met, all solenoid valves shall be closed. The heat pipe is provided with 4 stages of reheat, the 4 stages of reheat shall be controlled based on a 0.5°F dead band. For control of the heat pipe individual solenoid valves, the space mounted temperature sensor shall be polled on a 5-minute basis.
   1. If the space temperature is more than 0.5°F below setpoint when polled, a solenoid valve shall open.
   2. If space temperature is at or above setpoint when polled, a solenoid valve shall be closed.

G. Dehumidification Control:
   1. General: It is assumed that this unit will operate in the Dehumidification mode for a signifiant amount of time.
   2. Provide unit with a duct mounted DPT sensor mounted in the exhaust air stream at the inlet of the unit. The unit shall enter dehumidification mode if exhaust DPT levels rise above setpoint of 55°F DPT (adj). While in dehumidification mode, the leaving chilled water coil air temperature shall be reset down. A 2°F DPT deadband shall be used to determine the leaving chilled water setpoint.
      a. Exhaust DPT level at or below setpoint: Discharge air temp to match programed setpoint as defined under “Chilled Water Coil Control”.
      b. Exhaust DPT level 2°F above setpoint: Discharge air temperature from chilled water coil = 55°F (adj).
      c. Exhaust DPT temperature with-in dead band range: Vary linearly.
   3. While in dehumidification mode, the average space temperature shall not be allowed to drop more than 3°F below the space cooling setpoint. In the event space temperatures drop to this temperature, the Heating Hot Water System shall be activated if currently deactivated allowing the zone reheat coils to modulate to maintain space temperature that 2°F below setpoint.
      a. The heating hot water command shall be canceled when the DPT rises to 1°F above setpoint.

H. Energy Recovery Wheel Control:
   1. When outdoor air temperature is above 75°F (adj):
      a. The energy recovery wheel shall operate, (wheel bypass damper shall be closed).
   2. When outdoor air temperature is between 72°F (adj.) and 60°F (adj.).
      a. The energy recovery wheel shall not operate and its associated bypass damper shall be open.
   3. When the outdoor air temperature is below 60°F.
      a. The energy recovery wheel shall operate and the wheels bypass damper shall be closed.

I. System Start-up: When a unit has been called to start-up by the BAS, the following shall occur in sequential order:
   1. The units control valve shall open to a minimum position of 50% (adj) or as required to achieve discharge air temperature (whichever is greater) for a minimum period of 15 minutes (adj).
   2. The supply fan shall activate and operate under its normal sequence.
   3. After the start-up period, the valve shall return to its normal operating mode.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) when switch back from Morning Cool-down Mode to normal operations mode.

J. System Shut-down: When a unit has been called to shut-down by the BAS, the following shall occur in sequential order:
   1. The units 2-way control valve shall lock in its current position while SA & EA fans are deactivated.
   2. The SA and EA fans speed shall be reduced to its minimum setting over a period of 5 minutes (adj).
   3. Once SA & EA fans have reached their minimum set-point, the SA and EA fans shall be deactivated.
   4. After SA & EA fans have been deactivated, the units hot and chilled water control valves shall close if open.
      a. The closing speed of the chilled water control valve shall not be allowed to exceed more than 10% per minute (adj) during System Shut-down mode.

K. Freeze Protection:
   1. Freeze protection wire shall be serpentine across the entire face of the water coil every six inches on center.
      a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
      b. If a temperature of 40°F (adj.), or less is detected, then the supply air and exhaust air fans shall stop, outside air and exhaust air dampers shall fully close, the hot water control valve shall go full open and an audio/visual alarm shall activate through the BAS.
      c. Upon correction of the problem, the system shall be reset and shall return to normal operation.

L. Temperature Indication: Provide air temperature indication in the supply and return ducts and entering/leaving air temperature to each water coil.

M. UV Disinfection: The UV Disinfection system shall be on when unit is active, provide relays and contactors as required to control manufactured supplied UV lights.

N. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.

4. Outdoor-air-temperature indication.
5. Outdoor humidity indication (measured at inlet OA duct)
6. Outdoor CO2 ppm level, (obtain from FMS).
7. Enthalpy wheel status, (on/off/failure to start).
8. Enthalpy wheel inlet exhaust temperature
9. Enthalpy wheel outlet exhaust temperature
10. Enthalpy wheel inlet supply temperature
11. Enthalpy wheel outlet supply temperature
12. Enthalpy wheel bypass damper position
13. Supply-fan on-off indication, (on/off/failure to start).
14. Supply-fan-discharge static-pressure indication.
15. Supply-fan-discharge static-pressure set point.
16. Supply-fan airflow rate.
17. Supply-fan speed.
18. Exhaust-fan on-off indication, (on/off/failure to start).
19. Exhaust-fan-discharge static-pressure indication.
20. Exhaust-fan-discharge static-pressure set point.
21. Exhaust-fan airflow rate.
22. Exhaust-fan speed.
23. Face & bypass damper status.
24. Face & bypass damper position.
25. Relative humidity indication, (EA inlet duct and OA outlet duct).
26. Supply filter air-pressure-drop indication.
27. Supply filter low-air-pressure set point.
28. Supply filter high-air-pressure set point.
29. Exhaust filter air-pressure-drop indication.
30. Exhaust filter low-air-pressure set point.
31. Exhaust filter high-air-pressure set point.
32. OA-discharge air-temperature indication, (from sensor mounted in discharge duct).
33. OA-discharge air-temperature set point, (from sensor mounted in discharge duct).
34. Cooling-coil air-temperature indication.
35. Cooling-coil air-temperature set point.
36. Cooling-coil control-valve position (calculated not measured).
37. Chilled water return temperature.
38. Heating-coil air-temperature indication.
39. Heating-coil air-temperature set point.
40. Heating-coil control-valve position (calculated not measured).
41. Freeze stat status.
42. UV Disinfection Status.

O. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. DOAU Trend #1: (To be trended on a 5-minute basis)
      a. SA fan speed
      b. Energy wheel status
      c. DPT
      d. Discharge air temperature setpoint
      e. Discharge air temperature
      f. Face & Bypass Damper Position
      g. CHWR temperature
   2. DOAU Trend #2: (To be trended on a 5-minute basis)

a. Supply duct static pressure
b. Toilet exhaust static pressure
c. General exhaust duct damper position

3. DOAU Trend #3
   a. Chilled Control valve % opened
   b. Hot Control valve % opened
   c. Face & Bypass Damper Position
   d. Chilled water return water temperature
4. VAV AHU Trend #3: (To be trended on a 5-minute basis)
   a. Provide trend of damper position for all terminal boxes connected to unit on one common page.

1.14 KITCHEN AIR HANDLING UNIT (UNIT WITH WRAP AROUND COIL AND MELINK CONTROLS)

A. General: Unit shall consist of the following components:
   1. Flat Plate type space temperature sensor.
   2. Space mounted humidity sensor.
   3. Supply fan with VFD.
   4. Provide current switch to prove fan status.
   5. Hot water pre-heat coil with modulating 2-way control valve.
   6. Chilled water coil with modulating 2-way control.
   7. Wrap-around heat pipe reheat coil with 4-stages of control.
   8. Hot water reheat coil.
   9. OA & RA control dampers.
   10. Kitchen exhaust fans (KEF) KEF-1A and KEF-1B.
   11. Space temperature setpoint shall be input through the unit's web page, a minimum of 4°F offset shall be provided between the heating and cooling setpoints. At start-up the unit shall have a space cooling setpoint of 73F (adj) and heating setpoint of 68F (adj).

B. Modes of Operation: There shall be two (2) different modes of control for this unit.
   1. Mode-1: In general, temperature control with-in the space is accomplished by varying fan speed.
      a. The RA damper shall be 100% open and the OA damper shall be 100% closed when operating in Mode-1.
   2. Mode-2: Total airflow supplied to the space is determined by the speed of the various operating kitchen exhaust fans (KEFs) with space temperature control by varying supply air temperature.
      a. The RA damper shall be 100% closed and the OA damper shall be 100% open when operating in Mode-2.

C. Space Temperature Sensor Types: Flat Plate type.

D. Supply Air Fan Control, Mode-1: The supply air fan shall modulate based on space temperature, a 4°F (adjustable) dead band shall be utilized to control the fans speed for cooling mode and a 2°F dead band for heating. Mode-1 minimum CFM shall be set to 1500 CFM; Mode-1 maximum CFM shall be set to 2000 CFM. Fan speed shall modulate as follows:
   a. Cooling Mode:
      1) Space temperature 2°F below setpoint: Supply fan shall be at minimum speed.
      2) Space temperature 2°F above setpoint: Supply fan shall be at Mode-1 maximum speed.
      3) Space temperature between 2°F below and 2°F above setpoint: Vary linearly.
   b. Heating Mode:
      1) Space temperature 1°F below setpoint: Supply fan shall be at Mode-1 maximum speed.
      2) Space temperature 1°F above setpoint: Supply fan shall be at minimum speed.

3) Space temperature between 1°F below and 1°F above setpoint: Vary linearly.

c. When space temperatures are between the cooling and heating dead band range, the supply fans shall be at its minimum setpoint.

E. Supply Air Fan Control, Mode-2: The supply fan speed shall modulate based on the total exhaust from the operating kitchen exhaust fans. The minimum speed shall match that of Mode-1 with max speed matching the AHU's units scheduled value. The total amount of kitchen exhaust shall be determined as follows:

1. Kitchen Hood Control Panel (Melink) will provide a weighted average 0-10V signal via. hardwired connection that represents the total kitchen exhaust. The AHU VFD shall modulate based on the control signal as follows
   a. Weighted average less than 1V: Kitchen AHU supply fan shall operate under Mode-1 sequence.
   b. Weighed average equal to 1V: Kitchen AHU fan speed shall be as required to supply 2,000 cfm (minimum airflow under Mode 2).
2. Chilled Water Coil Control: The control valves shall modulate to maintain discharge air temperature based on a 4°F (adj) cooling space temperature dead band.
   a. Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 62°F (adj).
   b. Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
   c. Space temperature between limits: Vary linearly.

F. Pre-Heat Coil Temperature Control: The control valve shall modulate as required to maintain a leaving air temperature of 50F (adj). The control valve shall be closed when entering air temperatures are above 50F (adj).

G. Chilled Water Coil Control: The control valves shall modulate to maintain discharge air temperature based on a 4°F (adj) cooling space temperature dead band.

1. Space temperature 2°F below cooling setpoint: Cooling coil discharge air temperature 62°F (adj).
2. Space temperature 2°F above cooling setpoint: Cooling coil discharge air temperature 55°F (adj).
3. Space temperature between limits: Vary linearly.

H. Wrap-Around-Heat Pipe Coil Control: The heat pipe shall be available for reheat only when the entering air temperature to the inlet side of the upstream heat pipe coil is 5°F (adj) greater than the discharge air temperature from the chilled water coil, if this condition is not met, all solenoid valves shall be closed. The heat pipe is provided with 4 stages of reheat, the 4 stages of reheat shall be controlled based on a 0.5F dead band. For control of the heat pipe individual solenoid valves, the space mounted temperature sensor shall be polled on a 5-minute basis.

1. If the space temperature is more than 0.5F below setpoint when polled, a solenoid valve shall open.
2. If space temperature is at or above setpoint when polled, a solenoid valve shall be closed.

I. Reheat Coil Control: The control valves shall modulate to maintain a heating space temperature dead band of 1°F with exceptions as noted under the dehumidification sequence.

1. Space temperature 1°F below heating setpoint: Discharge air temperature 80°F (adj).
2. Space temperature 1°F above heating setpoint: Discharge air temperature 72°F (adj).
3. Space temperature between limits: Vary linearly.
4. When space temperatures are between the cooling and heating dead band range the reheat coil control valve shall be closed.

J. Dehumidification Control:

1. Provide unit with a space mounted humidity sensor, coordinate location of sensor with engineer if not indicated on the drawings. The unit shall enter dehumidification mode if space humidity levels rise above setpoint of 55% RH (adj). While in dehumidification mode, the leaving chilled water coil air temperature shall be reset down. A 4% humidity dead band shall be used to determine the leaving chilled water setpoint.
    a. Space humidity level at or below setpoint: Discharge air temp to match programed setpoint as defined under “Chilled Water Coil Control”.
    b. Space humidity level 4% above setpoint: Discharge air temperature from chilled water coil = 53F (adj).
    c. Space humidity levels with-in dead band range: Vary linearly.
2. While in dehumidification mode, the space temperature shall not be allowed to drop more than 2F below the space cooling setpoint. In the event space temperatures drop to this temperature, the Heating Hot Water System shall be activated if currently deactivated and the reheat coil shall modulate to maintain space temperature that is 2°F below setpoint.

K. Freeze Protection:
1. Freeze protection wire shall be serpentine across the entire face of the pre-heat coil every six inches on center.
    a. A low limit temperature sensor shall be located on the downstream side of the hot water coil.
    b. If a temperature of 40 degrees F (adj.), or less is detected, the supply air fan shall stop, OA dampers shall fully close, RA damper shall fully open, the pre-heat hot water control valve shall full open and an alarm shall activate through the BAS.
    c. Upon correction of the problem, the system shall be manually reset and shall return to normal operation.

L. UV Lights: These units are equipped with UV lights. 120V power is being provided by Division 26 contractor, provide relays and contacts as required to control UV lights so that the equipment is on only when the supply air fan is operating.

M. Display Points:
1. DDC system web page
2. Space temperature (if more than one sensor is present show temperature for each sensor and the average temperature)
3. Space humidity level
4. Dehumidification mode stage
5. Fan status (on/off/failure to run)
6. Supply fan speed (% of full speed)
7. Supply fan cfm (this is based on the fan speed, not a separate airflow monitor)
8. Exhaust fan cfm for each KEFs, (via hardwired Melink weighted average)
9. Totaled exhaust cfm from all KEFs
10. Return air temperature
11. Pre-heat coil entering air temperature
12. Pre-heat coil discharge air temperature
13. Pre-heat coil freeze stat status
14. Upstream heat pipe coil entering air temperature (this is the coil upstream of the chilled water coil)
15. Chilled water coil entering air temperature
16. Chilled water coil leaving air temperature
17. Heat-pipe reheat coil LAT
18. Heat-pipe coil, number of solenoid valves open
19. How Water Reheat coil discharge air temperature
20. Hot Water pre-heat coil control valve % of full open (software point, not actual measured)
21. Coiling-coil control valve % of full open (software point, not actual measured)

22. Hot water reheat heating-coil control valve % of full open (software point, not actual measured)
23. Chilled water coil return water temperature
24. Airflow monitoring station (inlet air probe preferred).
25. Kitchen Exhaust Fan status via CT
26. Kitchen Hood Control Panel Emergency Contacts

N. Trend Points: The following points shall be trended on a common web page accessible by clicking on an icon from the unit's system web page.
   1. Trend No. 1: Airflow Trends
      a. Supply fan CFM (to be based on SAF VFD speed, coordinate with TAB)
      b. Each individual KEF CFM
      c. Total combined exhaust CFM from KEFs (to be based on KEF's VFD speed, coordinate with TAB).
      d. Average space temperature
      e. Space relative humidity
   2. Trend No. 2: Temperature Trends
      a. Average space temperature
      b. Space relative humidity
      c. Chilled water coil discharge set-point
      d. Upstream heat pipe coil entering air temperature
      e. Chilled water coil entering air temperature
      f. Chilled water coil leaving air temperature
      g. Downstream heat pipe coil leaving air temperature
      h. Pre-heat coil discharge air temperature
      i. Cooling coil control valve % open
      j. Pre-heat coil control valve % open
      k. Reheating coil control valve % open
      l. Heat pipe coil, number of solenoid valves open
      m. Chilled water coil return water temperature
   3. Trend No. 3: Heat-Pipe Temperature Trends
      a. Number of heat-pipe valves open
      b. Heat-pipe pre-conditioning coil EAT
      c. Heat-pipe pre-conditioning coil LAT (this is the same as chilled water coil EAT)
      d. Heat-pipe reheat coil EAT (this is the same as the chilled water coil LAT)
      e. Heat-pipe reheat coil LAT
      f. Hydronic reheat coil LAT

1.15 FAN-COIL UNIT CONTROL

A. Fan-Coil Unit with Chilled and Hot Water Coil
   1. General: Fan-coils consist of ECM supply motor, 2-way chilled water coil control valve, 2-way hot water coil control valve and condensate overflow switch.
      a. Provide and install condensate overflow alarm that will stop unit on alarm
   2. Space Temperature Sensor Types: Flat Plate type.
   3. Occupancy: Terminal boxes shall be placed into operation based on a time of day schedule through the front-end control system.
   4. Space Temperature Control, Cooling: When cooling is required, modulate supply fan and chilled water control valve as required to maintain space temperature setpoint. (Heating valve shall be closed at this time).
   5. Space Temperature Control, Heating: When heating is required, modulate supply fan and hot water control valve as required to maintain space temperature setpoint. (Heating valve shall be closed at this time).

6. Central Plant Fan-coil Units:
    a. The central plant FCU's are provided with OA connection and automatic control damper.
    b. The control damper shall open and close based on space occupancy. Two (2) occupancy sensor shall be used to control the central plant general exhaust fan and OA damper. The OA damper shall remain open and exhaust fan on for a period of 5-minutes (adj) after occupancy was last detected.
7. Display:
    a. DDC system graphic
    b. Room/area served
    c. Space temperature
    d. Space temperature setpoint
    e. Discharge air temperature
    f. Chilled water control valve position as a percent of full
    g. Hot water control valve position as a percent of full
    h. Condensate overflow alarm
8. Trends: The following points shall be trended on a common web page accessible from the unit's web page.
    a. Fan status
    b. Space temperature
    c. Discharge air temperature
    d. Chilled water control valve position
    e. Hot water control valve position

1.16 TERMINAL UNIT OPERATING SEQUENCES

A. General Requirements: When a Terminal box for space cooling and terminal box for OA control are located in the same room and serve the same area, they shall be displayed on the same web page.

B. Space Temperature Sensor Types: Flat Plate type shall be installed through-out with limited exceptions in the Administration Suite.
    1. Refer to detail on drawings for temperature sensors located in:
        a. Principal's Office
        b. Conference Room
        c. Teachers Training Room.

C. Series Fan Powered VAV Box, (FVAV) with Electric Heating
    1. Occupancy: Terminal boxes shall be active when associated AHU is operational.
        a. Unit Shut-down: When the terminal units associated AHU has been shut down, the air valve in the terminal box shall 1st modulate to 100% open, then modulate closed then modulate back to 50% open. The damper shall remain 50% open until after the SAF has started, after unit operation has been proved, the unit shall operate per this sequence.
    2. Space Temperature Control:
        a. The supply fan shall be balanced to connected grille total listed on the drawings.
        b. When cooling is required, the air valve shall modulate between its minimum and maximum setting as required to maintain space temperature, (the maximum setting shall equal the total airflow connected to the terminal box).
        c. In the event that space temperatures drop 2F (adj) below cooling set point, the air valve shall go 100% closed.
        d. If heating is required, the supply air damper shall fully close and the electric heating coil shall modulate as required to satisfy set-point temperature.
    3. Display:

a. DDC system graphic.
b. Room/area served.
c. Maximum set point, (GRD Total).
d. Room temperature indication.
e. Room temperature set point.
f. Air-damper position as percent open.
g. Airflow.
h. Electric heating coil status/percent of load.

4. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Space temperature setpoint
   b. Space temperature
   c. Airflow
   d. Air-damper position as percent open.
   e. Discharge air temperature
   f. Percent of full load heating.

D. Single Inlet Terminal Box, (VAV) for cooling only
   1. General: This box provides cooling to the MDF room and other similar spaces.
   2. Occupancy:
      a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
      b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
   3. Air Valve Control: The air valve shall modulate from 0 – CFM listed on drawings as required to maintain space temperature set-point.
   4. Display:
      a. DDC system graphic.
      b. Space Temp Set-point
      c. Space Temperature
      d. Airflow.
      e. Air-damper position as percent open.
   5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
      a. Airflow
      b. Air-damper position as percent open.

E. Single Inlet Terminal Box, (VAV) with Electric Heating Coil
   1. General:
      a. This box provides cooling and heating to occupied spaces.
      b. The box is provide with air, control valve and electric heater with an SCR controller.
   2. Occupancy:
      a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
      b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
   3. Space Temperature Control:
      a. General:
         1) Boxes shall be provided with a minimum and maximum setpoint. On select boxes, the minimum and maximum setpoints are equal.
         2) General: Provide a 4°F (adj) offset between the heating and cooling setpoints.
            (a) The minimum offset between cooling and heating setpoints shall be 3°F.

b. Air Valve Control: The air valve shall modulate as required to maintain the desired airflow to the space.
   1) Space temperatures 1°F above cooling setpoint: Air valve shall be at its maximum setpoint.
   2) Space temperatures 1°F below below setpoint: Air valve shall be at its minimum setpoint.
   3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.
c. Electric Heating Coil SCR Control:
   1) Space temperatures 1°F above setpoint: The electric heating coil is off.
   2) Space temperatures 1°F below below setpoint: The electric heating coil is at full power.
   3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.

4. Display:
   a. DDC system graphic.
   b. Space Temp Set-point
   c. Space Temperature
   d. Airflow.
   e. Air-damper position as percent open.
   f. Electric heating coil percent of full power.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Air-damper position as percent open.
   c. Electric heating coil percent of full power.

F. Single Inlet Terminal Box, (VAV) with hydronic heating coil
1. General:
   a. This box provides cooling and heating to occupied spaces.
   b. The box is provided with air control valve and hydronic coil with modulating control valve.
2. Occupancy:
   a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
   b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Space Temperature Control:
   a. General:
      1) Boxes shall be provided with a minimum and maximum setpoint. On select boxes, the minimum and maximum setpoints are equal.
      2) General: Provide a 4°F (adj) offset between the heating and cooling setpoints.
         (a) The minimum offset between cooling and heating setpoints shall be 3°F.
   b. Air Valve Control: The air valve shall modulate as required to maintain the desired airflow to the space.
      1) Space temperatures 1°F above cooling setpoint: Air valve shall be at its maximum setpoint.
      2) Space temperatures 1°F below below setpoint: Air valve shall be at its minimum setpoint.
      3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.
   c. Hot Water Valve Control:
      1) Space temperatures 1°F above setpoint: Hot water control valve shall be closed.
      2) Space temperatures 1°F below below setpoint: Hot water control valve shall be 100% open.

3) Space temperature between 1°F above and 1°F below setpoint: Vary linearly.

4. Display:
   a. DDC system graphic.
   b. Space Temp Set-point
   c. Space Temperature
   d. Airflow.
   e. Air-damper position as percent open.
   f. Hot-water control valve position as percent open.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Air-damper position as percent open.
   c. Hot water control valve position.

G. Single Inlet Terminal Box, (VAV) for Space CO2 Control
1. General: This box is connected to OA Unit and is used to control space CO2 levels. It is a variable volume box.
2. Occupancy:
   a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.
      1) Unit Shutdown: When the terminal units associated AHU has been shut down, the air valve in the terminal box shall 1st modulate to 100% open, then modulate closed then modulate back to its minimum position. The damper shall remain at its minimum position until after the SAF has started, after unit operation has been proved, the unit shall operate per this sequence.
   b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.
3. Space CO2 Control:
   a. Obtain space CO2 differential from the Facility Monitoring System.
   b. The variable air inlet damper shall modulate between the minimum and maximum air flow rates as required to maintain a space differential of 500 ppm (adj) between OA and space CO2 levels.
4. Display:
   a. DDC system graphic.
   b. Room/area served.
   c. Minimum set point.
   d. Maximum set point.
   e. CO2 differential, (from FMS)
   f. Room occupied/unoccupied.
   g. Air-damper position as percent open.
   h. Actual airflow.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Air-damper position as percent open.
   c. Space CO2 DP

H. Single Inlet Terminal Box, (CAV)
1. General: This box is connected to OA unit and provides code required ventilation to the space. It is a constant volume box and is NOT controlled by space CO2 levels.
2. Occupancy:
   a. Occupied Mode: The terminal unit shall be placed into operation by the BAS based upon user defined schedule.

b. Unoccupied Mode: During the unoccupied mode, the terminal box shall stroke 100% closed then modulate back to a 50% open position.

3. Air Valve Control: The air valve shall modulate as required to maintain a constant air volume as indicated on drawings.
4. Display:
   a. DDC system graphic.
   b. Room/Area/AHU served.
   c. CFM Set-point, (terminal box is constant volume).
   d. Room occupied/unoccupied.
   e. Air-damper position as percent open.
   f. Actual airflow.
5. Diagnostic Trends: The following points shall be trended on a common web page accessible from the terminal box's web page.
   a. Airflow
   b. Airflow setpoint
   c. Air-damper position as percent open.

1.17 GENERAL EXHAUST FAN CONTROL

A. General: Where exhaust fans are provided for general exhaust purposes, (refer to plans for actual location), interlock exhaust fan with air handling unit servicing general area. Provide and install CT on motor for status check.

B. Display:
   1. DC system graphic.
   2. Exhaust fan status
   3. Occupancy status.

1.18 EXHAUST FAN CONTROL WITH OCCUPANCY SENSOR

A. General: Where occupancy sensor(s) are indicated for fan control, provide sensor and required contractor and relay control wiring as required to start fan when space is occupied.

B. Display:
   1. DC system graphic.
   2. Exhaust fan status
   3. Occupancy status.

1.19 DISHWASHER HOOD EXHAUST SYSTEM

A. General: Interlock dishwasher with exhaust fan. Provide and install CT on motor for status check.

B. Display:
   1. DDC system graphic.
   2. Exhaust fan status.
   3. Dishwasher fan status.

1.20 KITCHEN REFRIGERATOR AND FREEZER

A. General: Provide a wall-mounted temperature sensor in the walk-in refrigerator and freezer units to monitor temperature.
   1. If temperatures exceed a pre-designated set-point (adj) an alarm shall be generated at the BAS

B. Display and Trend Points: Provide display for freezer and cooler and trend points on a 5-minute basis.

1.21 HIGH VOLUME LOW SPEED CEILING FAN

A. General: These fans are being provided with local speed control by the manufacture. Provide start/stop signal via occupancy schedule. Coordinate requirements with fan manufacture

B. Display:
   1. DDC system graphic.
   2. Fan status.

1.22 VENTILATION FANS

A. General: These fans are being provided cooling of IT closets and storage spaces in buildings on the site located at the atheletic fields, refer to drawings and schedules for quantity and locations. Provide the following devices for these spaces:
   1. Provide space mounted line voltage temperature sensor to control fan. Line voltage stat shall be set to maintain 80F space temperature.
   2. Fan CT to monitor status.
   3. Room temperature sensor for monitoring temperature through BAS system.

B. Display:
   1. DDC system graphic.
   2. Fan status via CT.
   3. Space temperature.

C. Alarms:
   1. Alarm in the event that temperatures exceed 88F (adj).

1.23 DUCTLESS SPLIT SYSTEMS, IT CLOSET COOLING

A. General: Ductless split systems shall operate under their own control, install and wire manufacturer provided thermostat. Provide the following additional controls components:
   1. Condensate overflow alarm in drain pan.
   2. Wall mounted temperature sensor to allow monitoring of space temperature

B. Display:
   1. Space temperature.
   2. Space temperature alarm (alarm when space temp reaches 78F (adj))
   3. Condensate overflow alarm

1.24 DUCTLESS SPLIT SYSTEMS, GENERAL CONDITIONING

A. General: Ductless split systems shall operate under their own control, install and wire manufacturer provided thermostat. Condensing units are provided with dry-contacts for on/off control and scheduling by BAS. Note, many of these units are located in remote buildings such as concession stands and press boxes out on the site.

B. Provide condensate overflow in drain pan.

C. Occupancy Scheduling:
   1. The unit shall be scheduled through the BAS system.
   2. Timed Override:
      a. Where indicated on the plans, install a timed override button. When activated, the unit shall operate for a period of 2-hours (adj).

D. Display:
   1. Unit status (programmed not via CT)
   2. Condensate overflow alarm

1.25 EXTERIOR LIGHTING CONTROL

A. General: Mechanically held contactor type relay panels are being provided for building site-lighting control. Refer to lighting control detail located on drawing E602 & E701 for additional requirements. Provide connection to all lighting control panels indicated on electrical panels including:
   1. Elec 118: Panel LC1E
   2. Elec 215: Panels LC1
   3. Elec 412: Panels LC4 & LC4E
   4. Elec 714: Panels LC7 & LC7E
   5. Mech/Elec 1324: Panels LC13 & LC13E
   6. Concessions 2200: LCTC & LCTCE: Two (2) seperate lighting control schedules are required as follows
      a. Concession stand interior lighting.
      b. General athletic exterior site lighting.
   7. Concessions 2300: LCBC & LCBCE- Provide control of the two individual lighting zones.
      a. Concession stand interior lighting.
      b. General athletic exterior site lighting.

B. Lighting Control: Provide time of day control via exterior lighting schedule, both lighting controllers shall use a common schedule.

C. Time Out Override: Provide "Time Override Buttons" and locate as follows:
   1. Provide Override Button in Admin Suite to control lighting circuits powered from High School, (LC1, LC1E, LC4, LC4E, LC7, LC7E, LC13 & LC13E). On activation of button, the exterior lighting shall operate for a period of 1-hr (adj).
   2. Provide two (2) Override buttons in the Concession Stand.
      a. Button #1 shall activate all of the exterior athetlic buildings exterior lighting for a period of 1-hr (adj).
      b. Button #2 shall activate the Concession Stand interior lighting.

D. Display:
   1. Status
   2. Lighting schedule

1.26 RELAY LIGHTING PANELS

A. General: Relay type lighting control panels have been provided for control of specific interior lighting. Refer to lighting control details located on electrical drawings for additional information. All interior lighting control panels shall share a common time of day schedule. Provide connection to the following relay lighting control panels:
   1. Elec 412: Panel LR4
   2. Elec 714: Panels LR7
   3. Main Elec 1002.2: Panel LR10
   4. Mech/Elec 1324: LR13
   5. Elec 1624: LR16

B. Lighting Control Schedules: Provide individual time of day schedules for the following areas:
   1. Dinning Room, Main Lobby and Main Corridor.
   2. Gym and Gym Lobby
   3. Auditorium Lobby

C. Display:
   1. Status
   2. Lighting schedule

1.27 SHELTER IN PLACE

A. General: A wall mounted push button in the Admin Suite shall active a "shelter-place" mode. Under this condition, all OA equipment and Exhaust equipment, (with the exception of the kitchen hood system) shall be shut-down. Units that do not have OA connections shall not shut-down when activated.

1.28 DOMESTIC WATER HEATERS

A. General: Provide control of domestic water recirculation pumps. Pumps shall be controlled via a time of day schedule.

B. Display:
   1. Pump status via current sensor (for each pump)
   2. Discharge water temperature from domestic water heaters serving kitchen.
   3. Discharge water temperature from domestic water heaters general building.

1.29 BUILDING HUMIDITY SENSORS

A. General: Provide wall mounted humidity sensors where indicated on the drawings.

B. Display: Floor plan with location of humidity sensors including.
   1. Wall mounted humidity sensors
   2. Humidity sensors mounted in the RA or EA duct of AHU and/or OA units

1.30 ENERGY METER

A. General: Two electrical meters are being provided that will be monitored through the BAS. These include (1) at MSBA Switchboard and (1) at MSBB Switchboard. The BAS shall read information from each meter via control interface (coordinate protocol with meter provider)

B. Display:
   1. KWH Week-to-Date
   2. KWH Month-to-Date
   3. KWH Year-to-Date KWH
   4. KWH for each previous year
   5. Peak Demand (KW) Week-to-Date
   6. Peak Demand (KW) Month-to-Date
   7. Peak Demand (KW) Year-to-Date
   8. Peak Demand (KW) for each previous year

C. Trend Data:
   1. Trend Demand on a 15-minute interval for each switchboard.

1.31 PHASE FAILURE PROTECTION

A. General: Provide and install phase failure detection device at each main switch board (MSBA & MSBB). On detection of phase failure, BAS shall shall command all 3 phase equipment that it is controlling to stop. Equipment shall automatically start 10-minutes (adj) after power to the phase has been restored.

B. Alarm:
   1. Provide alarm with date & time stamp when loss of phase occured.
   2. Log date and time that power that phase power has been restored.

1.32 CTE EQUIPMENT MONITORING

A. General: Proivde current switches to monitor the status of CTE ventilation equipment SCES-01, SCES-02, SCES-03 and DC-1.

B. Display:
   1. Status for each piece of equipment.

C. Alarm:
   1. Provide alarm if equipment is operating outside of normal occupancy mode.

D. Trend Log:
   1. Trend operation equipment on a change of state.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 23 2113
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic system requirements.

B. Heating water and glycol piping, above grade.

C. Chilled water piping, above grade.

D. Condenser water piping, above grade.

E. Equipment drains and overflows.

F. Pipe hangers and supports.

G. Unions, flanges, mechanical couplings, and dielectric connections.

H. Valves:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.

1.02 RELATED REQUIREMENTS

A. Section 08 3100 - Access Doors and Panels.

B. Section 23 0719 - HVAC Piping Insulation.

C. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2021.

C. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.

D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.

F. ASME B31.9 - Building Services Piping 2020.

G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2022.

H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2023a.

I. ASTM B32 - Standard Specification for Solder Metal 2020.

J. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.

L. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 2021a.

M. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) 2020.

N. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2023.

O. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 2020.

P. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping 2021a.

Q. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

R. ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing 2023b.

S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers 1992 (Reapproved 2022).

T. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).

U. ASTM F2389 - Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems 2023.

V. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

W. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2022).

X. AWWA C606 - Grooved and Shouldered Joints 2022.

Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Include data on pipe materials, pipe fittings, valves, and accessories.

1.05 QUALITY ASSURANCE

A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary protective coating on cast iron and steel valves.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

A. Comply with ASME B31.9 and applicable federal, state, and local regulations.

B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
   1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
   2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
   3. Grooved mechanical joints may be used in any location.
      a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
      b. Grooved mechanical connections and joints comply with AWWA C606.
      c. Use rigid joints unless otherwise indicated.
   4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.

C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.

D. Valves: Provide valves where indicated:
   1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
   2. On discharge of condenser water pumps, use spring-loaded check valves.
   3. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
   4. For throttling, bypass, or manual flow control services, use ball or butterfly valves.
   5. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
   6. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
      a. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 CHILLED WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
   2. Threaded Joints: ASME B16.3, malleable iron fittings.
   3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
      a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.04 CONDENSER WATER PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
   1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings with finish matching piping; AWS D1.1/D1.1M welded.

2. Threaded Joints: ASME B16.3, malleable iron fittings with finish matching piping.
3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

B. PVC Pipe: ASTM D1785, Schedule 80, or ASTM D2241, SDR 21 or 26.
1. Fittings: ASTM D2466 or ASTM D2467, PVC.
2. Joints: Solvent welded in accordance with ASTM D2855.

C. Pressure-Rated Polypropylene Pipe: ASTM D2774 or ASTM F2389, PP-RCT resin pipe with fiber layer, SDR 17.6 or SDR 11.
1. Fittings: ASTM F2389, butt, socket, or saddle-weld heat fusion. Transitions to comply with ASTM F1960 or ASME B16.5.

2.05 EQUIPMENT DRAINS AND OVERFLOWS

A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.

2.06 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
16. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
17. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.07 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

A. Unions for Pipe of 2 Inches and Less:
1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
2. Copper Pipe: Bronze, soldered joints.

B. Flanges for Pipe 2 Inches and Greater:
   1. Ferrous Piping: 150 psig forged steel, slip-on.
   2. Copper Piping: Bronze.
   3. Gaskets: 1/16 inch thick, preformed neoprene.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
   1. Dimensions and Testing: In accordance with AWWA C606.
   2. Mechanical Couplings: Comply with ASTM F1476.
   3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
   4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. Dielectric Connections:
   1. Waterways:
      a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      b. Dry insulation barrier able to withstand 600-volt breakdown test.
      c. Construct of galvanized steel with threaded end connections to match connecting piping.
      d. Suitable for the required operating pressures and temperatures.
   2. Flanges:
      a. Dielectric flanges with same pressure ratings as standard flanges.
      b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
      c. Dry insulation barrier able to withstand 600-volt breakdown test.
      d. Construct of galvanized steel with threaded end connections to match connecting piping.
      e. Suitable for the required operating pressures and temperatures.
   3. Unions:
      a. 1/2 to 1 Inches: Brass solder to galvanized FPT.
      b. 1/2 to 2 Inches: Brass solder to galvanized FPT.
      c. 1/2 to 1 Inches: Brass to galvanized FPT or FIP (Female Iron Pipe).
      d. 3/4 to 1/2 Inch Reducer: Brass solder to galvanized FPT.
      e. Service: 250 psi, minus 20 to 180 deg F.

2.08 ACCEPTABLE VALVE MANUFACTURES

A. Manufacturers:
   1. Apollo Valves
   2. Nibco
   3. Victaulic Company
   4. Watts Corporation

2.09 BALL VALVES

A. Up To and Including 2 Inches:
   1. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

2.10 BUTTERFLY VALVES

A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, grooved, or _____ ends, extended neck.

B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, Buna-N encapsulation, or _____.

C. Operator: 10 position lever handle.

2.11 SWING CHECK VALVES

A. Up To and Including 2 Inches:
   1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

B. Over 2 Inches:
   1. Iron body, bronze or _____ trim, stainless steel, bronze, bronze faced rotating, or _____ swing disc, renewable disc and seat, flanged, grooved, or _____ ends.

2.12 SPRING LOADED CHECK VALVES

A. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment using jointing system specified.

E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

F. After completion, fill, clean, and treat systems. See Section 23 2500 for additional requirements.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install heating water, glycol, chilled water, condenser water, and engine exhaust piping to ASME B31.9 requirements.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and to avoid interference with use of space.

E. Group piping whenever practical at common elevations.

F. Sleeve pipe passing through partitions, walls, and floors.

G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified _____.

H. Slope piping and arrange to drain at low points.

I. Grooved Joints:
   1. Install in accordance with the manufacturer's latest published installation instructions.

J. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.

K. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.

L. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100 .

M. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

A. Pipe Application:
   1. Chilled Water Piping, Interior or Exterior Above Ground:
      a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints or Steel pipe with screwed fittings.
      b. Piping 2.5-inch and greater: Steel pipe with welded, flanged, or grooved fittings.
   2. Hot Water Piping, Interior or Exterior Above Ground:
      a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints or Steel pipe with screwed fittings.
      b. Piping 2.5-inch and greater: Steel pipe with welded, flanged, or grooved fittings.
   3. Condenser Water Piping, Interior Above Grade:
      a. All pipe sizes: Steel pipe with welded fittings.
   4. Condenser Water Piping, Exterior Above Ground:
      a. Piping 2-inch and less: Steel pipe with welded fittings.
      b. Piping 2.5-inch and greater: Steel pipe with welded fittings.
   5. Makeup-water Piping, Above Ground:
      a. Piping 2-inch and less: Copper pipe with brazed or press-fit joints.

B. Hanger Spacing for Copper Tubing.
   1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.

C. Hanger Spacing for Steel Piping.
   1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
   10. 10 Inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
   11. 12 Inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

D. Hanger Spacing for Plastic Piping.
   1. 1/2 Inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
   2. 3/4 Inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
   3. 1 Inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
   4. 1-1/4 Inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
   5. 1-1/2 Inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
   6. 2 Inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
   7. 3 Inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   8. 4 Inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
   9. 6 Inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
   10. 8 Inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.
   11. 10 Inches: Maximum span, 13 feet; minimum rod size, 3/4 inch.
   12. 12 Inches: Maximum span, 14 feet; minimum rod size, 7/8 inch.

END OF SECTION

SECTION 23 2114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Expansion tanks.
B. Air vents.
C. Air separators.
D. Strainers.
E. Suction diffusers.
F. Pressure-temperature test plugs.
G. Balancing valves.
H. Relief valves.
I. Pressure reducing valves.

1.02 RELATED REQUIREMENTS

A. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2023.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.
B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
   2. Amtrol Inc: www.amtrol.com/#sle.
   3. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   4. Taco, Inc: www.taco-hvac.com/#sle.
   5. Thrush Company.
   6. Substitutions: See Section 01 6000 - Product Requirements.
B. Acceptance Volume Capacity: As indicated on drawings.
C. Maximum Rated Working Pressure: 125 psi.

D. Maximum Allowable Service Temperature: 240 degrees F.

E. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.

F. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

G. Accessories: Provide air-charging fitting, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

A. Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.

B. Maximum Fluid Pressure: 150 psi.

C. Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

A. Centrifugal Air Separators/Strainers:
   1. Manufacturers:
      a. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
      b. Armstrong International, Inc: www.armstronginternational.com/#sle.
      c. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
      d. Taco, Inc: www.taco-hvac.com/#sle.
      e. Thrush Company.
      f. Substitutions: See Section 01 6000 - Product Requirements.
   2. Primed steel body, tested and stamped in accordance with ASME BPVC-VIII-1 with integral bronze strainer, tangential flanged inlet and outlet connections, and internal stainless steel air collector tube.
   3. Maximum Service Flow and Pressure: 4,500 gpm at 125 psi.
   4. Accessories: Provide epoxy coating finish and tank-bottom magnets.

2.04 STRAINERS

A. Size 2 inch and Under:
   1. Provide threaded or grooved brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2 inch to 4 inch:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.

C. Size 5 inch and Larger:
   1. Provide flanged or grooved iron body for up to 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

B. Class 125:
   1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.

2. Maximum Operating Service: 175 psi and 300 degrees F.
3. Sizes, Material, and Connection:
   a. 2 inch and Smaller: Cast iron body, threaded.
   b. 2-1/2 to 12 inch: Ductile iron body, flanged.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

A. Flexible Connectors: Flanged, EPDM rubber sphere type with wetted components of stainless steel, sized to match piping.
   1. Maximum Operating Service: 150 psi at 120 degrees F.
   2. End Connections: Same as specified for pipe jointing.
   3. Provide necessary accessories including, but not limited to, swivel joints.

2.07 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.08 BALANCING VALVES

A. Manufacturers:
   1. American Wheatley, a company of Global Flow Products, LLC: www.wheatleyhvac.com/#sle.
   2. Armstrong International, Inc: www.armstronginternational.com/#sle.
   3. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
   4. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
   5. Taco, Inc: www.taco-hvac.com/#sle.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Size 2 inch and Smaller:
   1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and NPT threaded connections.
   2. Metal construction materials consist of bronze or brass.
   3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.

C. Size 2-1/2 inch and Larger:
   1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged or grooved connections.
   2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
   3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.09 RELIEF VALVES

A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.10 PRESSURE REDUCING VALVES

A. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.

B. Materials of Construction:
   1. Valve Body: Constructed of bronze, cast iron, brass, or iron.
   2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.

C. Connections:

1. NPT threaded: 1/2 inch or 3/4inch.
2. Soldered: 1/2 inch.

D. Provide integral check valve and strainer.

E. Maximum Inlet Pressure: 400 psi.

F. Maximum Fluid Temperature: 180 degrees F.

G. Adjustable Pressure Range: From 10 to 45 psi, set to 25 psi.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Provide manual air vents at system high points and as indicated.

C. Provide air separator on suction side of system circulation pump and connect to expansion tank.

D. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.

E. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.

F. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

G. Pipe relief valve outlet to nearest floor drain.

END OF SECTION

SECTION 23 2123
HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. End-suction pumps.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 23 0934 - Variable-Frequency Motor Controllers.

C. Section 25 3500 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

1.03 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

E. Certification of Pump Alignment: Manufacturer representative shall certifiy that the pump alignment meets all manufacture requirements.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Pump rebuild kit for each size pump. Rebuild kit to include complete seal/gasket kit and bearing kit.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle.

B. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.

C. Aurora Pump.

D. Peerless.

E. Patterson.

F. Paco.

G. Taco.

H. Substitutions: See Section 01 6000 - Product Requirements.

2.02 GENERAL

A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

B. Electrical Requirements:
   1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
   2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 0934, except for integral-VFDs.
   3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 END-SUCTION PUMPS

A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.

B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.

C. Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.

D. Bearings: Grease lubricated roller or ball bearings.

E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.

F. Seal: Mechanical, 225 degrees F maximum continuous duty temperature.

G. Drive: Flexible coupling with coupling guard.

H. Baseplate: Cast iron or fabricated steel with integral drain rim.

I. Electrical:
   1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 23 0513.
   2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Manufacturer shall certified field alignment after pump installation is complete.

C. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.

D. Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.

E. Provide air cock and drain connection on horizontal pump casings.

F. Controls Human-Machine Interface (HMI): HVAC operator terminal; see Section 25 3500.

END OF SECTION

SECTION 23 2300
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Filter-driers.

1.02 RELATED REQUIREMENTS

A. Section 23 0716 - HVAC Equipment Insulation.

B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers 2009.

B. AHRI 711 (SI) - Performance Rating of Liquid-Line Driers 2009.

C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2022, with Errata (2023).

D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.

F. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes 2018.

G. ASME B31.5 - Refrigeration Piping and Heat Transfer Components 2022.

H. ASME B31.9 - Building Services Piping 2020.

I. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.

K. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service 2020.

L. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018, with Amendment (2019).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide general assembly of specialties, including manufacturer's catalogue information. Provide manufacturer's catalog data including load capacity.

C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

D. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

B. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.

C. Valves:
   1. Use service valves on suction and discharge of compressors.

D. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

E. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

2.02 REGULATORY REQUIREMENTS

A. Comply with ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

2.03 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8-inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   1. Fittings: ASME B16.26 cast copper.
   2. Joints: Flared.

C. Pipe Supports and Anchors:
   1. Provide hangers and supports that comply with MSS SP-58.
      a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   5. Vertical Support: Steel riser clamp.
   6. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   7. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   8. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 REFRIGERANT

A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.05 MOISTURE AND LIQUID INDICATORS

2.06 MOISTURE AND LIQUID INDICATORS

A. Indicators: Single port type, UL listed, with copper or brass body, flared or soldered ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.07 VALVES

2.08 VALVES

A. Ball Valves:
   1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

B. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

2.09 STRAINERS

2.10 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.11 FILTER-DRIERS

2.12 FILTER-DRIERS

A. Performance:
   1. Flow Capacity - Liquid Line: ____ ton, minimum, rated in accordance with AHRI 710 (I-P) (AHRI 711 (SI)).
   2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
   3. Design Working Pressure: 350 psi, minimum.

B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.

C. Construction: UL listed.
   1. Connections: As specified for applicable pipe type.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain-end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.5.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
   4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   5. Provide copper plated hangers and supports for copper piping.

G. Flood piping system with nitrogen when brazing.

H. Insulate piping and equipment.

I. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

J. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

K. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

L. Fully charge completed system with refrigerant after testing.

M. Provide electrical connection to solenoid valves. See Section 26 0583.

3.03 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Test refrigeration system in accordance with ASME B31.5.

C. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using halide torch. Test and repair piping until no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 2500
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Materials.
   1. System cleaner.
   2. Closed system treatment (water).
   3. Condenser water system treatment (cooling towers).

B. By-pass (pot) feeder.

C. Solution metering pump.

D. Solution tanks.

E. Conductivity controller.

F. Water meter.

G. Side-stream filtration equipment.

1.02 RELATED REQUIREMENTS

A. Section 01 6000 - Product Requirements: Owner furnished treatment equipment.

1.03 REFERENCE STANDARDS

A. UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.

C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.

D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

F. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

G. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nalco, an Ecolab Company: www.nalco.com/#sle.

B. Substitutions: See Section 01 6000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.

B. Comply with UL (DIR) requirements.

C. Perform work in accordance with local health department regulations.

2.03 MATERIALS

A. System Cleaner:
   1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
   2. Biocide chlorine release agents such as sodium hypochlorite or calcium hypochlorite or microbiocides such as quarternary ammonia compounds, tributyltin oxide, methylene bis (thiocyanate).

B. Closed System Treatment (Water):
   1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
   2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

C. Condenser Water System Treatment (Cooling Towers):
   1. Manufacturers:
      a. Nalco, an Ecolab Company: www.nalco.com/#sle.
   2. Sequestering agent to inhibit scaling; phosphonates, sodium polyphosphates, lignin derivatives, synthetic polymer polyelectrolytes, or organic phosphates.
   3. Acid to reduce alkalinity and pH; sulphuric acid.
   4. Corrosion inhibitor; zinc-phosphate, phosphonate-phosphate, phosphonate-molybdate and phosphonate-silicate, sodium tolyltriazole, or low molecular weight polymers.

2.04 BY-PASS (POT) FEEDER

A. 6.0 gal quick opening cap for working pressure of 175 psi.

2.05 SOLUTION METERING PUMP

A. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.

2.06 SOLUTION TANKS

A. 30 gallon capacity, polyethylene, self-supporting, 1 gallon graduated markings; molded fiberglass cover with recess for mounting pump, agitator, and liquid level switch.

2.07 CONDUCTIVITY CONTROLLER

A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit.

2.08 WATER METER

2.09 SIDE-STREAM FILTRATION SYSTEM

A. System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.

B. Hot Water Filter Housing: Glass reinforced nylon plastic suitable for 220 degrees F and 200 psi operating conditions.

C. Chilled Water Filter Housing: Reinforced polypropylene plastic housing suitable for 125 degrees F and 125 psi operating conditions.

D. Cartridges: 30 micron for start-up and 5 micron for system operation.

PART 3 EXECUTION

3.01 PREPARATION

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.05 CONDENSER WATER SYSTEMS (COOLING TOWERS)

A. Provide automatic condenser water control systems for inhibitor feed, blowdown and biocide feeds. Inhibitor application shall be meter activated, blowdown shall be conductivity activated, and biocide shall be meter fed with blowdown locked out to ensure biocide retention time.

B. Control system shall incorporate solid state integrated circuits and digital LED displays, in NEMA-12 steel enclosure. Provide gasketed and lockable door.

C. Base dissolved solids control on conductivity and include:
   1. LED digital readout display (micro-ohm/cm).
   2. Temperature compensated sensor probe adaptable to sample stream manifold.
   3. High, low, normal conductance indicator lights (LED).
   4. High or low conductance alarm light (flash or steady switch), trip points field adjustable. Flash or steady switch shall have silence position.
   5. Illuminated legend shall indicate "ALARM" whenever alarm condition exists.
   6. Hand-off-automatic switch for solenoid bleed valve.
   7. Illuminated legend shall indicate "BLEED" when valve is operated.

D. Base inhibitor feed control on make-up volume and include:
   1. Solid state counter (1-15 field selectable).
   2. Solid state timer (adjustable 1/4 to 5 minutes).
   3. Test switch.
   4. Hand-off-automatic switch for chemical pump.
   5. Illuminated legend shall indicate "FEED" when pump is activated.
   6. Solid state lock-out timer (adjustable 1/4 to 3 hours) and indicator light. Lock-out timer shall deactivate the pump and activate alarm circuits.
   7. Panel totalizer (amount of makeup), electro-mechanical type.

E. Biocide programmer to include:
   1. 24 hour timer with 14 day skip feature to permit activation any hour of the day.
   2. Precision solid state bleed lock-out timer (0-9 hours) and biocide pump timer (0 - 2-1/4 hours), clock controlled.
   3. Solid state alternator to enable the use of two different formulations.
   4. Digital display of the time of day (24 hours).

5. LED display of day of week (14 days).
6. Battery back-up so clock is not disturbed by power outages, quartz timekeeping accuracy.
7. Hand-off-automatic switches for biocide pumps.
8. Illuminated legend shall indicate "BIOCIDE A" or "BIOCIDE B" when pump is activated.

F. Provide water meter on system make-up, wired to control system.

G. Provide solution pumps to feed sequestering agent and corrosion inhibitor from solution tank into condenser water supply to tower. Provide agitator as required.

H. Provide conductivity controller to sample condenser water and operate 1 inch solenoid bleed valve and piping to blowdown controller sampler wired to open when condensing water pump is operating.

I. Introduce biocide to tower by intermittent slug feed.

J. Provide liquid level switch in each solution tank to deactivate solution pump and agitator and sound local alarm bell.

K. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

3.06 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.
1. Provide minimum of two hours of instruction for two people.
2. Have operation and maintenance data prepared and available for review during training.
3. Conduct training using actual equipment after treated system has been put into full operation.

3.07 MAINTENANCE

A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.

B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.

C. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.

D. Provide laboratory and technical assistance services during this maintenance period.

E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

END OF SECTION

SECTION 23 3100
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Metal ducts.

B. Flexible ducts.

C. Air plenums and casings.

D. Ducts for kitchen exhaust applications.

1.02 RELATED REQUIREMENTS

A. Section 07 8400 - Firestopping.

B. Section 11 4000 - Foodservice Equipment: Kitchen range hoods.

C. Section 23 0713 - Duct Insulation: External insulation and duct liner.

D. Section 23 3300 - Air Duct Accessories.

E. Section 23 3319 - Duct Silencers.

F. Section 23 3600 - Air Terminal Units.

G. Section 23 3700 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

D. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

E. ASTM E2336 - Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems 2020.

F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2024.

H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2024.

I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

J. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.

K. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

L. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors Current Edition, Including All Revisions.

M. UL 1479 - Standard for Fire Tests of Penetration Firestops Current Edition, Including All Revisions.

N. UL 1978 - Grease Ducts Current Edition, Including All Revisions.

O. UL 2221 - Tests of Fire Resistive Grease Duct Enclosure Assemblies Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for duct materials.

C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.

D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).

E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.05 FIELD CONDITIONS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.

B. Provide metal duct unless otherwise indicated.

C. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 23 3319.

D. Duct Shape and Material in accordance with Allowed Static Pressure Range:

E. Duct Sealing and Leakage in accordance with Static Pressure Class:
   1. Low Pressure Service: Up to 2 in-wc:
      a. Seal: Class C, apply to seal off transverse joints.
      b. Leakage:
         1) Rectangular: Class 24 or 24 cfm/100 sq ft.
         2) Round: Class 12 or 12 cfm/100 sq ft.
   2. Low Pressure Service: From 2 in-wc to 3 in-wc:
      a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
      b. Leakage:
         1) Rectangular: Class 12 or 12 cfm/100 sq ft.
         2) Round: Class 6 or 6 cfm/100 sq ft.
   3. Medium and High Pressure Service: Above 3 in-wc:
      a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
      b. Leakage:
         1) Rectangular: Class 6 or 6 cfm/100 sq ft.
         2) Round: Class 3 or 3 cfm/100 sq ft.

F. Duct Fabrication Requirements:
   1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
   2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.

3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

2.03 METAL DUCTS

A. Material Requirements:
   1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.

B. Flat-Oval Metal Ducts:
   1. Flat-Oval Single Wall Duct: Machine made from a round spiral lock seam duct.
      a. Fittings: Manufacture at least two gauges heavier metal than the duct.
      b. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
   2. Flat-Oval Double Wall Insulated Duct: Machine made from round spiral lock seam duct.
      a. Fittings: Manufacture with solid inner wall.
      b. Inner Wall: Perforated galvanized steel.
      c. Insulation:
         1) Thickness: 1 inch fiberglass.

C. Round Metal Ducts:
   1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
   2. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
      a. Insulation:
         1) Thickness: 1 inch.
         2) Material: Air.
   3. Round Connection System: Interlocking duct connection system per SMACNA (DCS).

D. Round Spiral Duct:
   1. Round spiral lock seam duct with galvanized steel outer wall.

E. Connectors, Fittings, Sealants, and Miscellaneous:
   1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
   2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
   3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
      a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
      b. VOC Content: Not more than 250 g/L, excluding water.

c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.

4. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.04 FLEXIBLE DUCTS

A. Vapor Barrier Insulated Flexible Air Ducts:
   1. UL 181, Class 1, two-ply polyester or vinyl film supported by helically wound spring steel wire.
   2. Pressure Rating: From 10 in-wc positive to 1 in-wc negative.
   3. Temperature Range: Minus 10 to 160 degrees F.

B. Uninsulated Flexible Air Ducts:
   1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
   2. Pressure Rating: From 10 in-wc to 1 in-wc negative.
   3. Temperature Range: Minus 20 to 210 degrees F.

2.05 AIR PLENUMS AND CASINGS

A. Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.

B. Minimum Fabrication Requirements:
   1. Fabricate acoustic plenum or casing with reinforcing turned inward.
   2. Provide 16-gauge, 0.059-inch sheet steel back facing and 22-gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.
   3. Construct panels 3 inches thick, packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch sheet steel.
   4. Mount floor-mounted plenum or casings on 4-inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.

C. Access Doors:
   1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
   2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
   3. Provide clear wire glass observation ports, minimum 6 by 6 inch size.

2.06 DUCTS FOR KITCHEN EXHAUST APPLICATIONS

A. Provide ductwork, fittings, and appurtenances per NFPA 96, SMACNA (KVS), UL 1978, and UL 2221 requirements and guidelines.

B. Class 1 duct for air with gas and grease particle exhaust at an air velocity of 1,500 to 2,500 fpm.

C. Where ducts are not self-draining back to equipment, provide low-point drain pocket with the copper drain pipe to a sanitary sewer.

D. Design, fabricate, and install liquidtight preventing exhaust leakage into building.

E. Dishwasher Exhaust Duct:
   1. Duct Size: 1/2 in-wc pressure class stainless steel.
   2. Fabricate using single wall, 20-gauge, 0.035-inch Type 304 stainless steel with external welded joints.
   3. Seal joints during installation with factory-supplied overlapping V-bands and sealant.

F. Kitchen Hood and Grease Exhaust Duct:

1. Fabricate in accordance with ductwork manufacturer's instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.
2. Rectangular, Single-Wall, Premanufactured Grease Exhaust Duct:
   a. UL Listed and labeled to UL 1978.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
3. Zero Clearance, 2-Hour Fire-Rated, Rectangular, Double-Wall, Premanufactured Grease Duct:
   a. Listed when tested in accordance with UL 1978 and ASTM E2336.
   b. Construct of 16-gauge, 0.059-inch sheet steel using continuous external welded joints in rectangular sections.
   c. Liquidtight with continuous external weld for seams and joints.
   d. Where ducts are not self-draining back to equipment, provide low-point drain pocket with copper drain pipe to sanitary sewer.
   e. Through-penetration firestop listed to UL 1479 or ASTM E814.
4. Grease Exhaust Duct Access Doors:
   a. Listed when tested in accordance with UL 1978.
   b. Install hinged access doors where indicated or required for access for cleaning and inspection of duct.
   c. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, support, and seal ducts in accordance with SMACNA (DCS).

B. Install products following the manufacturer's instructions.

C. Comply with safety standards NFPA 90A and NFPA 90B.

D. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

F. Kitchen Range Hoods: Install when provided by Section 11 4000 then fit-out with respective ductwork and accessories to interconnect exhaust system.

G. Kitchen Hood Exhaust: Provide residue traps at the base of vertical risers with provisions for the cleanout.

H. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.

I. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

J. Use double nuts and lock washers on threaded rod supports.

K. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

L. Louver Fit-out:
   1. Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
   2. Use the same duct material painted black on the exterior side, then seal louver frame and duct.

M. Fire Partitions: Provide firestopping sealing. See Section 07 8400.

N. Duct Accessories, Terminal Units, Inlets, and Outlets: Interconnect as indicated in Sections 23 3300, 23 3600, and 23 3700.

O. Duct Insulation: Provide duct insulation. See Section 23 0713.

END OF SECTION

SECTION 23 3300
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Combination fire and smoke dampers.

B. Duct access doors.

C. Duct test holes.

D. Fire dampers.

E. Flexible duct connectors.

F. Smoke dampers.

G. Volume control dampers.

H. Low leakage (Class 1A) control dampers.

1.02 RELATED REQUIREMENTS

A. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

B. NFPA 92 - Standard for Smoke Control Systems 2021, with Amendment.

C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

D. UL 33 - Safety Heat Responsive Links for Fire-Protection Service Current Edition, Including All Revisions.

E. UL 555 - Standard for Fire Dampers Current Edition, Including All Revisions.

F. UL 555C - Standard for Safety Ceiling Dampers Current Edition, Including All Revisions.

G. UL 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.

D. Manufacturer's Installation Instructions: Provide instructions for fire dampers.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Arrow United Industries, www.arrowunited.com.
   2. Greenheck, www.greenheck.com.
   3. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
   4. Nailor Industries, Inc: www.nailor.com/#sle.
   5. Pottorff: www.pottorff.com/#sle.
   6. Ruskin Company: www.ruskin.com/#sle.

7. United Enertech: www.unitedenertech.com/#sle.
8. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.

C. Ratings:
1. Fire Resistance: Damper shall match wall ratings (1.5-hrs or 3-hrs), refer to architectural plans for wall ratings.
2. Fire Closure Temperature: 165 degree F.Each combination fire-smoke damper shall be equipped with a factory installed heat responsive device rated to close the damper when the temperature at the damper reaches 165 degree F.
3. Elevated Operational Temperature: Dampers shall have a UL 555S elevated temperature rating of 250°F.

D. Construction:
1. Frame: Damper frame shall be 16 ga. galvanized steel formed into a 5 in. x 1 in. structural hat channel. Dampers less than 17 in. high shall utilize low profile geometry and 20 ga. galvanized steel for the top and bottom frame members to maximize free area. Frame shall be 4-piece construction with 1 ½ in. (minimum) integral overlapping gusset reinforcements in each corner to assure square corners and provide maximum resistance to racking. No welding of damper frames shall be permitted.
2. Seals:
   a. Blade Edge: Blade seals shall be extruded silicone rubber mechanically secured to the appropriate blade edges
   b. Jamb: Flexible stainless steel compression type.
3. Linkage: Blade linkages shall be non-adjustable and concealed within the jamb of the damper.
4. Axles: Minimum ½ inch dia. zinc plated steel.
5. Sleeves: Damper shall be supplied as a single assembly with a factory installed sleeve made of material matching that of the damper.
6. Fire Closure Device: Reusable Resettable Link.Mounting: Horizontal or Vertical, refer to plans for requirements.
7. Finish: Galvanized steel.
8. Actuators:
   a. Electric, 120V, 2-position.
   b. Mounting Location: External (outside of duct).
9. Retaining Angles: 1 ½" x 1 ¼" or 2 ½" x 1 ½".

E. Differential Pressure: Dampers shall have a UL 555S differential pressure rating of 4 in. wg.

F. Requirements for Fire and Smoke Dampers installed in Medium Pressure Systems:
1. Performance:
   a. Pressure Drop: The Damper manufacturer's submittal data shall certify that all pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal. AMCA certified pressure drop for a 24 in. wide x 24 in. high damper shall not exceed 0.06 in. wg when subjected to an airflow velocity of 1500 fpm according to AMCA Test Figure 5.3.
   b. Leakage: Dampers shall have a UL555S leakage rating of Leakage Class I. (8 cfm/ft2 (0.04 m3/ s/m2) at 4 in. wg (1.0 kPa).

2. Blades: Damper blades shall be of 14 ga. equivalent, galvanized steel with full length structural reinforcement and a double skin true airfoil shape. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Velocity: Dampers shall have a UL 555S velocity rating of 4000 fpm.

G. Requirements for Fire and Smoke Dampers installed in Low Velocity Systems:
1. Performance:
a. Pressure Drop: The damper manufacturer's submittal data shall certify that all pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal. AMCA certified pressure drop for a 24 in. wide x 24 in. high damper shall not exceed 0.09 in. wg when subjected to an airflow velocity of 1500 fpm according to AMCA Test Figure 5.3.
b. Leakage: Dampers shall have a UL555S leakage rating of Leakage Class II. (20 cfm/ft2 at 4 in. wg).
2. Blades: Damper blades shall be 16 ga. galvanized steel strengthened by three longitudinal 1 in. deep V-grooves running the entire length of each blade. Each blade shall be symmetrical relative to its axle pivot point, presenting identical performance characteristics with air flowing in either direction through the damper. Provide symmetrical blades of varying size as required to completely fill the damper opening.
3. Velocity: Dampers shall have a UL 555S velocity rating of 2000 fpm.

2.02 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
1. Less Than 12 inches Square: Secure with sash locks.
2. Up to 18 inches Square: Provide two hinges and two sash locks.
3. Larger Sizes: Provide an additional hinge.

C. Access doors with sheet metal screw fasteners are not acceptable.

2.03 DUCT TEST HOLES

A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.04 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

B. Ceiling (Radiation) Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame and 16-gauge, 0.0598-inch flap, two layers of 0.125-inch thick ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
1. Boot Fitting: Factory-provided el type (90 degree). Include field-provided collar.
2. Rated for one hour service in compliance with UL 555C.

C. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.

D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.

E. Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.05 FLEXIBLE DUCT CONNECTORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

2.06 SMOKE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

B. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.

C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.07 VOLUME CONTROL DAMPERS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Single Blade Dampers:
   1. Fabricate for duct sizes up to 6 by 30 inch.
   2. Blade: 24 gauge, 0.0239 inch, minimum.

C. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
   1. Blade: 18 gauge, 0.0478 inch, minimum.

D. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

E. Quadrants:
   1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
   2. Where rod lengths exceed 30 inches provide regulator at both ends.

2.08 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

A. Manufacturers:
   1. Ruskin Company; CD50: www.ruskin.com/#sle.
   2. United Enertech; _____: www.unitedenertech.com/#sle.

B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.

C. Frame:
   1. Material: 20-gauge galvanized steel.

D. Blade:
   1. Type: Multi-blade extruded airfoil for high pressure.
   2. Operation: Opposed type.

E. Other Requirements:
   1. Paint Finish: Standard.
   2. Sleeve or Flange: Factory-mounted standard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 3100 for duct construction and pressure class.

B. Provide duct test holes where indicated and required for testing and balancing purposes.

C. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

E. Demonstrate re-setting of fire dampers to Owner's representative.

F. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.

H. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION

SECTION 23 3416
CENTRIFUGAL HVAC FANS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

A. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014 (Reaffirmed 2020).

B. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.

C. AMCA 99 - Standards Handbook 2016.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.

E. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.

F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ACME Engineering and Manufacturing Corporation; _____: www.acmefan.com/#sle.

B. Carnes, a division of Carnes Company Inc; VIBK: www.carnes.com/#sle.

C. Loren Cook Company; _____: www.lorencook.com/#sle.

D. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

E. Rosenberg USA, Inc; _____: www.rosenbergusa.com/#sle.

F. Twin City Fan & Blower; _____: www.tcf.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

A. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

C. Fabrication: Comply with AMCA 99.

D. Static and Dynamic Balance: Eliminate vibration or noise transmission to occupied areas.

2.03 WHEEL AND INLET

A. Backward Inclined: Steel or aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

B. Forward Curved: Black enameled steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and back plate; steel hub swaged to backplate and keyed to shaft with set screw.

C. Airfoil Wheel: Steel construction with smooth curved inlet flange, heavy backplate die-formed hollow airfoil shaped blades continuously welded at tip flange, and backplate; cast iron or cast steel hub riveted to backplate and keyed to shaft with set screws.

2.04 HOUSING

A. Heavy gauge steel, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

B. Factory finish before assembly to manufacturer's standard. For fans handling air downstream of humidifiers, provide two additional coats of paint. Prime coating on aluminum parts is not required.

2.05 BEARINGS AND DRIVES

A. Bearings: Heavy duty pillow block type, selfgreasing roller bearings, or ABMA STD 11 life at 120,000 hours.

B. Shafts: Hot rolled steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flexible connections between fan inlet and discharge ductwork; see Section 23 3300. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

END OF SECTION

SECTION 23 3423
HVAC POWER VENTILATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof exhausters.

B. Cabinet exhaust fans.

C. Inline centrifugal fans and blowers.

D. Kitchen hood upblast roof exhausters.

E. Utility vent blower sets.

F. Laboratory-fume exhaust fans.

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.

B. AMCA 99 - Standards Handbook 2016.

C. AMCA 204 - Balance Quality and Vibration Levels for Fans 2020.

D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.

E. AMCA 211 - Certified Ratings Program Product Rating Manual for Fan Air Performance 2022, with Editorial Revision (2023).

F. AMCA 260 - Laboratory Methods of Testing Induced Flow Fans for Rating 2020.

G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.

H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.

I. AMCA 311 - Certified Ratings Program Product Rating Manual for Fan Sound Performance 2016.

J. ANSI Z9.5 - Laboratory Ventilation 2022.

K. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

L. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2024.

M. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

1.05 FIELD CONDITIONS

A. Permanent ventilators may be used for ventilation during construction only after ductwork is clean, filters are in place, bearings have been lubricated, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carnes, a division of Carnes Company Inc; _____: www.carnes.com/#sle.

B. Greenheck Fan Corporation; _____: www.greenheck.com/#sle.

C. Loren Cook Company; _____: www.lorencook.com/#sle.

D. PennBarry, Division of Air System Components; _____: www.pennbarry.com/#sle.

E. Twin City Fan & Blower; _____: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL

A. Static and Dynamically Balanced: Comply with AMCA 204.

B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.

C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.

D. Fabrication: Comply with AMCA 99.

E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

F. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.03 ROOF EXHAUSTERS

A. Fan Unit: Direct driven unless otherwise noted, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.

B. Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.

C. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.

D. Backdraft Damper: Aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.

E. Sheaves: When required, cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

F. Performance Ratings: As indicated on drawings.

2.04 CABINET EXHAUST FANS

A. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.

B. Grille: Molded white plastic.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

2.05 INLINE CENTRIFUGAL FANS AND BLOWERS

A. Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.

B. Backward Inclined Blower:

1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, powder-coated steel housing for outdoor service, and removable service panels.
2. Accessories: Provide external vibration isolator spring.

C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

D. Performance Ratings: As indicated on drawings.

2.06 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

A. Direct Drive Fan:
1. Fan Wheel:
a. Type: Non-overloading, backward inclined centrifugal.
b. Material: Aluminum, statically and dynamically balanced.
2. Housing:
a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
b. Rigid internal support structure.
c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
e. Provide breather tube for fresh air motor cooling and wiring.

B. Shafts and Bearings:
1. Fan Shaft:
a. Ground and polished steel with anti-corrosive coating.
b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
a. Permanently sealed or pillow block type.
b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
c. 100 percent factory tested.

C. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

D. Disconnect Switches:
1. Factory mounted and wired in NEMA 3R Encloseure.
2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
3. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
4. Positive electrical shutoff.
5. Wired from fan motor to junction box installed within motor compartment.

E. Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:

1. Birdscreen:
2. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
3. Grease Trap:
    a. Container system to collect grease residue.
    b. Maintain 40" height from roof surface to discharge of fan.
4. Hinge Kit:
    a. Hinges and restraint cables mounted to base sleeve.
5. Tie-down Points: Four brackets located on windband secures fan in heavy wind applications.

H. Performance Ratings: As indicated on drawings.

2.07 UTILITY VENT BLOWER SETS

A. Manufacturers:
1. Greenheck Fan Corporation: www.greenheck.com/#sle.
2. Loren Cook Company: www.lorencook.com/#sle.
3. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
4. Twin City Fan & Blower; BCV: www.tcf.com/#sle.

B. Direct Drive Fan:
1. Fan Wheel:
    a. Type: Non-overloading, backward inclined centrifugal.
    b. Material: Aluminum, statically and dynamically balanced.
2. Housing:
    a. Construct of heavy gauge aluminum including curb cap, windband, and motor compartment.
    b. Rigid internal support structure.
    c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
    d. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
    e. Provide breather tube for fresh air motor cooling and wiring.

C. Shafts and Bearings:
1. Fan Shaft:
    a. Ground and polished steel with anti-corrosive coating.
    b. First critical speed at least 25 percent over maximum cataloged operating speed.
2. Bearings:
    a. Permanently sealed or pillow block type.
    b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
    c. 100 percent factory tested.

D. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
2. Belts: Static free and oil resistant.
3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
4. Motor pulley adjustable for final system balancing.
5. Readily accessible for maintenance.

E. Disconnect Switches:
1. Factory mounted and wired in NEMA 3R enclosurer.
2. Finish for Painted Steel Enclosures: Provide manufacturer's standard or factory-applied gray unless otherwise indicated.
3. Positive electrical shutoff.

4. Wired from fan motor to junction box installed within motor compartment.

F. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

G. Options/Accessories:
1. Dampers: Provide motorized type.

H. Performance Ratings: As indicated on drawings.

2.08 LABORATORY FUME-EXHAUST FANS

A. Manufacturers:
1. Greenheck Fan Corporation: www.greenheck.com/#sle.
2. Loren Cook Company: www.lorencook.com/#sle.
3. Twin City Fan & Blower: www.tcf.com/#sle.

B. General Requirements:
1. Fan Type: Roof-curb mounted, constant stack-velocity discharge laboratory exhaust.
2. Minimum air discharge velocity of 3,000 fpm in compliance with ANSI Z9.5.
3. Provide fan-assembly manufactured to sustain structural integrity without external guy-wires or supplemental supports at wind speeds up to 125 mph.
4. Fan performance tested in accordance with AMCA 210, AMCA 260, and AMCA 300.
5. Fan performance ratings certified in accordance with AMCA 211 and AMCA 311.

C. Application:
1. Dedicated Fume Hood Exhaust:
a. Fan Type: Direct-driven, single-speed motor with epoxy-based protective coating.
b. Exhaust Capacity: Select fan to handle full exhaust airflow rate, system static pressure loss with 15 percent load-capacity factor, and minimum discharge plume height of 10 feet above roof level.

D. Fan Section Requirements:
1. Impeller:
a. Non-overloading, backward-inclined centrifugal.
b. Material: Aluminum.
2. Fan Shaft:
a. Ground and polished steel with anticorrosive coating.
b. First critical speed at least 25 percent over maximum cataloged operating speed.
c. Enclosed over OSHA recommended safety-yellow painted guards.
3. Bearings:
a. 100 percent factory tested surface-mounted bearings outside of the airstream.
b. Operate during a minimum L10 service life in excess of 100,000 hours at maximum cataloged operating speed.
4. Housing:
a. Construct of heavy gauge aluminum with standard factory finish.
b. Mounting Base:
1) External mounting base with lifting lugs.
c. Construct drive frame assembly of heavy gauge steel, mounted on vibration isolators.
d. Provide breather tube for fresh air motor cooling and wiring.
e. Minimum Assembly Height: 120 inches above the roof surface.
5. Isolation Damper:
a. With parallel blade damper, constructed of matching materials and finish.
b. Provided by manufacturer, bolted to access drawer or panel for easy removal from contaminated airstream.
c. With two-position damper actuator:
1) Provided by manufacturer.

2) Operate interlocked with fan starter.
3) With integral auxiliary switches to monitor blade position status.
4) Rated for NEMA 250, Type 4 (IP66) environment within protective weather-housing out of contaminated airstream, connected through linkages.

6. Fan Discharge Outlet-Nozzle:
   a. High Plume: Conical shaped nozzle manufactured to facilitate attaining a required air-discharge velocity of constantly to lightly reduced exhaust flows.
7. Fan Inlet Flow Sensor: Provide factory-mounted pitot tube-based differential pressure sensor probe ready for use by TAB to balance fan.

E. Fan Bypass Air Plenum:
   1. Constant Volume Systems: For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum. Fans mounted directly to roof curbs shall be provided with a damper tray located in the roof curb for mounting of the gravity isolation damper.
   2. Variable Volume Systems: For variable volume systems, a bypass air plenum shall be provided as shown on drawings. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.

F. Disconnect Switch:
   1. Factory-mounted in NEMA 250, Type 3R box wired in compliance with Section 26 0583.
   2. Switchbox Finish: Manufacturer's standard unless otherwise indicated.

G. Roof Curbs:
   1. 12 inch high, self-flashing of matching material and finish with continuously welded seams.
   2. Provide integral formed steel support framework with curb cap guides.

H. Performance Ratings: As indicated on drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

END OF SECTION

SECTION 23 3439
HIGH-VOLUME, LOW-SPEED PROPELLER FANS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. High-volume, low-speed propeller fans.

1.02 REFERENCE STANDARDS

A. UL 507 - Electric Fans Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

C. Manufacturer's Instructions: Indicate installation instructions.

1.04 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 507.

B. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.02 HIGH-VOLUME, LOW-SPEED PROPELLER FANS

A. Manufacturers:
   1. Big Ass Fans; Essence: www.bigassfans.com/#sle.

B. Performance Ratings: Refer to drawing schedule.

C. Shafts and Bearings:
   1. Fan Shaft:
      a. Ground and polished steel with anti-corrosive coating.
      b. First critical speed at least 25 percent over maximum cataloged operating speed.
   2. Bearings:
      a. Permanently sealed or pillow block type.
      b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
      c. 100 percent factory tested.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure fan with stainless steel lag screws to structure.

END OF SECTION

SECTION 23 3513
DUST COLLECTION SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Dust Collection System

B. Ductwork and duct fittings.

C. Inlet fittings.

D. Accessories.

1.02 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2023.

B. AWS D9.1/D9.1M - Sheet Metal Welding Code 2018.

C. SMACNA (ROUND) - Round Industrial Duct Construction Standards 2013.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Shop Drawings: Indicate dimensions, sizes, weights and point loadings, material thickness, and locations and sizes of field connections. Submit construction layout and details for inlet fittings.

C. Product Data: Provide manufacturers literature and data indicating rated capacities, dimensions, weights and point loadings, accessories, electrical characteristics and connection requirements, wiring diagrams, and location and sizes of field connections.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit sound power levels for both fan inlet and outlet at rated capacity.

F. Manufacturer's Installation Instructions: Indicate assembly and installation instructions.

G. Operation and Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements, for additional provisions.
   2. Extra Filters: One

PART 2 PRODUCTS

2.01 DUST COLLECTION SYSTEM

A. Manufacturers:
   1. Donaldson Filtration Solutions.
   2. Sternvent

B. General:
   1. Intermittent duty, shaker fabric filter dust collection as shown on the plans and/or listed on the equipment schedule. The collector will include a fan section, filter section and hopper(s) with legs and quick release seal mechanism for connection to integral dust bin.

C. Construction:
   1. The collector housing, hopper(s) and supports shall be constructed of carbon steel and the housing reinforced for maximum pressure of the integral fan.
   2. Exterior surfaces shall have a durable, textured multi-coat urethane finish which passes a 2000-hour salt spray test. Interior surfaces shall be primed only.

3. The collector will be supplied with lift-off hinged doors for access to the fan and filter chamber. No tools shall be required for filter removal and replacement.
4. The collector will have mechanism designed to accept two (2) 55-gallon drum (no fasteners or clamps are required).
5. The fan shall discharge into a special fan chamber designed for noise reduction.

D. Hopper:
1. The hopper(s) shall have a deflector plate at the dirty air inlet to direct large particles directly into the dust bin and distribute the air.
2. The hopper shall be supplied with covered openings so air inlets may be located on either side or the rear.
3. Dust laden air will flow upward into the filter section which shall contain a single, multi-envelope filter with spring steel wire mesh inserts fitted with wear liners.

E. Filters:
1. Slide out filter assembly shall be supported on runners retained by a quick release lever.
2. Filtered air shall flow into the fan section.
3. Filter cleaning occurs after each fan shut down.
4. Filter shaking is via an eccentric mounted on TENV motor located on the side of the housing.

F. Controller:
1. A controller shall be furnished, consisting of start/clean pushbuttons, timer and motor contactors with overloads for the fan and shaker motors, all in a NEMA 12 enclosure. The controller shall automatically activate the filter shaker motor for 35 seconds each time the fan is shut off.

G. Capacity: Refer to drawing schedules for additional requirements.

2.02 DUCTWORK AND DUCT ACCESSORIES

A. Materials:
1. Galvanized Steel Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M, FS Type B, with G90/Z275 coating.
a. Thickness: Base sheet steel, 24 gauge, 0.0239 inch minimum.

B. Ductwork:
1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
3. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA (ROUND). Prime coat welded joints.
4. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow, with liquid adhesive plus sheet metal screws.
5. Joints: Minimum 4 inch cemented slip type, brazed, or electric welded to comply with AWS D9.1/D9.1M.
6. Provide standard 45-degree lateral wye branch fittings unless otherwise indicated.
7. Use double nuts and lock washers on threaded rod supports.

C. Flexible Connectors: UL listed, fire-retardant chloroprene or chlorosulfonated polyethylene impregnated fabric, minimum density 20 oz per sq yd, approximately 2 inches wide, crimped into metal edging strip.

D. Angle Rings: Carbon steel, unpainted, leg out, drilled with bolt holes.

E. Blast Gates: Half collar of cast aluminum, with galvanized steel slide, set screw.

F. Flat Back Elbows: Long radius rectangular elbow at duct material with heavy gauge, removable, stainless steel back strip.

G. Ball Joints: Cast iron with tubular studs for connecting ducts, allowing 25 degree angle off center.

H. Floor Sweeps: Galvanized Steel with 4" drop, 12x3 inch opening at floor level with spring load cover.

2.03 INLET FITTINGS

A. Fabricate from 16 gauge, 0.0598 inch galvanized steel, minimum base sheet thickness.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions.

B. Install flexible connections at fan inlet and discharge. Ensure metal bands of connectors are parallel with minimum 1-inch flex between ductwork and fan while running.

END OF SECTION

SECTION 23 3600
AIR TERMINAL UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single-duct terminal units.
   1. Constant-volume units.
   2. Variable-volume units.

B. Fan-powered units.

1.02 RELATED REQUIREMENTS

A. Section 23 0548 - Vibration and Seismic Controls for HVAC.

B. Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).

B. AHRI 880 (I-P) - Performance Rating of Air Terminals 2017 (Reaffirmed 2023).

C. ASHRAE Std 130 - Laboratory Methods of Testing Air Terminal Units 2016.

D. ASTM A492 - Standard Specification for Stainless Steel Rope Wire 1995 (Reapproved 2019).

E. ASTM A603 - Standard Specification for Metallic-Coated Steel Structural Wire Rope 2019.

F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems 2008.

J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.

C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
   1. Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc.

D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.

E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Motors: Two of each type and size.

PART 2 PRODUCTS

2.01 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS

A. Manufacturers:
   1. Krueger-HVAC
   2. Nailor Industries.
   3. Metalaire, a brand of Metal Industries Inc
   4. Price Industries, Inc.
   5. Titus.
   6. Substitutions: See Section 01 6000 - Product Requirements.

B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
   1. Single-Duct Terminal Unit: SDV, (direct digital controls).
   2. Single-Duct Terminal Units for Electric Coils: SDV-EC, (electric heating coil with direct digital controls).

C. General:
   1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
   2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.

D. Unit Casing:
   1. Minimum 22 gauge, 0.0299 inch galvanized steel.
      a. Casing leakage to meet ASHRAE Std 130.
   2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, with slip-and-drive connections.
   4. Acceptable Liners:
      a. 3/4 inch thick polyurethane foam adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.
      b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.

E. Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
   2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak damper blades for tight airflow shutoff.

F. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
   2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
   3. Coil leak tested to minimum 350 psig.
   4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.

G. Electric Heating Coil:
   1. Listed and provided by the terminal unit manufacturer.

2. Coil Casing: 20 gauge, 0.0359 inch galvanized steel.
3. Heating Elements: Nickel chrome, supported by ceramic insulators.
4. Integral Control Panel: NEMA 250, Type 2 enclosure with hinged access door for access to all controls and safety devices.
5. Furnish a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow.
6. Provide the following additional components, mounted and/or wired within the control enclosure:
   a. Fused or non-fused door interlocking disconnect switch.
   b. Mercury contactors.
   c. Fuse block.
7. Factory wired, including all limit switches and steps of control as indicated on the equipment schedule, with the SSR (solid-state relay) proportional heat control.
8. Provide SCR (Silicon Controlled Rectifier) controller.

H. Electrical Requirements:
1. Single-point power connection.
2. Equipment wiring to comply with requirements of NFPA 70.

I. Factory Mounted and Wired Controls:
1. Control Transformers: Factory supplied and mounted for electric and electronic control applications.
2. Wiring Terminations: Fan controls to terminal strip. Terminal lugs to match quantites, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

2.02 FAN-POWERED SERIES UNITS

A. Manufacturers:
1. Krueger-HVAC.
2. Metalaire, a brand of Metal Industries Inc.
3. Nailor Industries.
4. Price Industries, Inc.
5. Trane, a brand of Ingersoll Rand.
6. Titus.
7. Substitutions: See Section 01 6000 - Product Requirements.

B. Basis of Design: Price Industries, Inc: www.priceindustries.com/#sle.
1. Constant-Volume Series Fan-Powered Unit: FDC, (direct digital controls).

C. General:

1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.

D. Unit Casing:
   1. Minimum 22 gauge, 0.0299 inch galvanized steel.
   2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
   3. Unit Discharge: Rectangular, suitable for flanged duct connection.
   4. Acceptable Liners:
      a. 3/4 inch thick polyurethane foam adhesive complying with UL 181 erosion requirements in accordance with ASHRAE Std 62.1, and having a maximum smoke developed index of 50 for both insulation and adhesive, when tested in accordance with ASTM E84.

E. Primary Air Damper Assembly:
   1. Heavy-gauge, galvanized steel, or extruded aluminum construction with solid shaft rotating in bearings.
   2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
   3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff.
   4. Fan(s): Forward curved, centrifugal type.
   5. Fan Motor:
      a. ECM (Electrically Commutated Motor):
         1) Brushless DC controlled by an integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator.
      b. Fan motor shaft directly connected to fan and isolated from unit casing to prevent transmission of vibration.

F. Electric Heating Coil:
   1. Listed and provided by the terminal unit manufacturer.
   2. Coil Casing: Minimum 20 gauge, 0.0359 inch galvanized steel.
   3. Heating Elements: Open wire, nickel chrome, supported by ceramic insulators.
   4. Integral Control Panel: NEMA 250, Type 2 enclosure, with hinged access door for access to all controls and safety devices.
   5. Provide a primary automatic reset thermal cutout and differential pressure airflow switch for proof of airflow or electrical interlock to prevent heater operation when fan is not running.
   6. Provide the following additional components, mounted and/or wired within the control enclosure:
      a. Fused or non-fused door interlocking disconnect switch.
      b. Mercury contactors.
      c. Fuse block.
   7. Provide SCR (Silicon Controlled Rectifier) controller.

G. Hot Water Heating Coil:
   1. Coil Casing: Minimum 22 gauge, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
   2. Heavy-gauge aluminum fins, mechanically bonded to tubes.
   3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.
   4. Coil leak tested to minimum 305 psig.
   5. Base performance data on tests run in accordance with AHRI 410.

H. Electrical Requirements:
   1. Single-point power connection.
   2. Equipment wiring to comply with requirements of NFPA 70.

I. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
   2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   3. Disconnect Switch: Factory-mounted, fuse type.

J. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 0548.

E. Do not support from ductwork.

F. Connect to ductwork in accordance with Section 23 3100.

END OF SECTION

SECTION 23 3700
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Diffusers:

B. Rectangular ceiling diffusers.

C. Round ceiling diffusers.

D. Fabric air distribution devices.

E. Louvers:

F. Roof hoods.

1.02 RELATED REQUIREMENTS

A. Section 09 9123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.03 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023c.

B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

C. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2024.

D. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.

E. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

G. UL 2518 - Standard for Safety Air Dispersion Systems Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.01 ROUND CEILING DIFFUSERS

A. Type: Round, adjustable pattern, stamped or spun, multicore diffuser to discharge air in 360-degree pattern, with sectorizing baffles where indicated. Project diffuser collar not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.

B. Color: As selected by Architect from manufacturer's standard range.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Type: Provide square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.

B. Connections: Round.

C. Frame: Provide inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.

D. Fabrication: Aluminum with baked enamel finish.

E. Color: As selected by Architect from manufacturer's standard range.

2.03 FABRIC AIR DISTRIBUTION DEVICES

A. General Requirements:
   1. Diffuser material to comply with ASTM E84, UL 723, UL 2518, NFPA 90A, and NFPA 90B.
   2. Air Dispersion Method:
   3. Hanger Supports:

2.04 LOUVERS

A. Type: 6 inch deep frame with drainable brades, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.

2.05 ROOF HOODS

A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).

B. Fabricate of galvanized steel, minimum 16 gauge, 0.0598 inch base and 20 gauge, 0.0359 inch hood, or aluminum, minimum 16 gauge, 0.0598 inch base and 18 gauge, 0.0598 inch hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat finish.

C. Fabricate louver penthouses with mitered corners and reinforce with structural angles.

D. Mount unit on minimum 12 inch high curb base with insulation between duct and curb.

E. Make hood outlet area minimum of twice throat area.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.

C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.

D. Install diffusers to ductwork with air tight connection.

E. Paint ductwork visible behind air outlets and inlets matte black, see Section 09 9123.

END OF SECTION

SECTION 23 3813.01
RESIDENTIAL-KITCHEN RANGE HOOD FOR COMMERCIAL BUILDINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Residential Kitchen Range Hoods.

1.02 RELATED REQUIREMENTS

A. Section 11 2013: Residential Appliances.

1.03 REFERENCE STANDARDS

A. IAPMO (UMC) - 2021 Uniform Mechanical Code 2021.

B. ICC (IFC) - International Fire Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. ICC (IMC) - International Mechanical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL (DIR) - Online Certifications Directory Current Edition.

F. UL 507 - Electric Fans Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Manufacturer's data indicating dimensions, capacity, operating features of the Hood, and installation instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Electrical Applianes: Listed and labeled by UL (DIR) and complying with NEMA Standards (National Electrical Manufacturers Association).

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Submit a written warranty, executed by the Manufacturer, agreeing to repair or replace equipment that fails in materials or workmanship within the specified warranty period.
   1. Warranty Period: One (1) year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Accurex, LLC: www.accurex.com.

B. Deniar Fire Protection: www.denlarhoods.com.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 HOOD REQUIREMENTS

A. Fully integrated, self-contained fire suppression range hood for residential appliances for use in protecting residential-grade appliances when used din public or otherwise commercial spaces.

B. General
   1. NFPA 101 compliant, provide with:
      a. 500 CFM factory-supplied integral fan.

b. Locked (password protected) appliance disconnect with timed-automatic range deactivation.
c. Manual pull station.

2. Kitchen ventilation hood shall be exhaust only, and cover a domestic range sizes 30” in commercial environments used for domestic purposes only.
3. ICC evaluated and certified as compliant with ICC (IMC), ICC (IFC), and IAPMO (UMC).
4. Fan shall be UL 507 listed or equivalent.
5. Hood fire suppression shall be UL listed to the UL Subject 300A.
6. Hood shall be configured as wall style (supplied with wall mounting bracket).
7. Integral fan options include either front recirculating or rear discharge. Front recirculating style shall include an easily accessible charcoal filter and opening in the front of the hood for filtering the exhaust air before discharging back into the space. Rear discharge shall direct the air to exit the back of the hood, to discharge through a wall to the outside. External fan options include either a factory-provided inline fan (with plug and play cable) or fan by others option with a top discharge hood configuration. Top discharge shall direct the air to exit the top of the hood, to discharge through a roof or wall to the outside All factory provided fan options shall include energy efficient electrically commutated motors (ECM) standard.

C. Hood Construction:
1. Construct of 18 gauge minimum, 300 series stainless steel outer shell.
2. Hood shall be either 30” long (to cover 30” range) or 36” long (to cover 36” range).
3. Hood shell shall be manufactured and assembled with no visible outer welds or weld marks. All internal seams shall be sealed with NSF-approved caulk.
4. Provide with a metal mesh filter.
5. Two (2) 2200-2700K color LED recessed hood lights shall provide over 50 foot-candles of evenly-dispersed lighting on the range below.

D. Fire Suppression System:
1. Factory-installed UL Subject 300A fire suppression system, including fully monitored electronic detection and actuation. Braided cable or fusible links shall be accepted.
2. Fire suppression shall consist of two (2) mounted metal-housed temperature sensors that monitor the cooking surface and upon reaching set-point, send a signal back to the main fire system control board, which activates the tank solenoid valve and expels the wet chemical from a pre-charged tank responsible for suppressing the fire. Tank pressure shall be monitored using tank pressure sensor and a fault must be displayed on the user interface if low pressure is detected.
3. Fire suppression and control components must be easily accessible by dropping the hood into a service position to allow for service without removing the hood. Latches shall be utilized to hold the hood into place for normal operation.
4. Include either an electronic or gas shut off device that shall be field connected back to the hood via factory-provided plug and play cables. Prior to fire suppression release, the shut off device shall be responsible for disabling the range upon detecting a high temperature. Gas disconnect (if provided) shall include a ¾” gas valve supplied with plug and play cable and a 115VAC control receptacle. Electric disconnect (if provided) shall include a 4-prong 250VAC 50A power receptacle. Other electric disconnect receptacle types are also available upon special request.

E. Hood Operation:
1. User interface can be utilized to turn on and off fans, lights, and range disconnect.
2. If configured for NFPA 101 life safety code, password entry will be required to engage disconnect. After range is turned on, count down timer will begin, and upon expiring will disengage the range disconnect.

3. Upon reaching specific set-point, exhaust fan will engage automatically if not already turned on and be forced to a speed based on a temperature range.
4. Upon reaching a second higher temperature set-point, the disconnect will be automatically shut off and a warning will appear on the user interface.
5. Upon reaching a preset temperature, the fire system will engage and discharge wet chemical on top of the range.

F. Accessories:
1. User Interface:
   a. User interface shall be provided to control fan, range, and lights and view system statuses, including faults/alarms.
   b. Full color 4.3” LCD touch screen. No toggle switches or rheostats shall be acceptable.All factory and configuration settings must be accessed by touchscreen through password-protected entry. For ADA compliance, the user interface can be shipped loose to be field mounted on a wall near the hood. If shipped loose, user interface shall be provided with factory supplied plug and play cable.
   c. Factory and configuration settings must be accessed by touchscreen through password-protected entry.
   d. ADA complianet, the user interface can be shipped loose to be field mounted on a wall near the hood. If shipped loose, user interface shall be provided with factory supplied plug and play cable.
2. Horn strobe, with plug and play cable.
3. K-class 6 liter wet chemical fire extinguisher.
4. Manual pull station, with plug and play cable.
5. Dry contacts are provided standard for tie into building alarm systems and supply fan integration.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify utility rough-ins are provided and correctly located.

3.02 INSTALLATION

A. Install in accordance with manufacturer's written instructions.

B. Anchor built-in equipment in place.

3.03 ADJUSTING

A. Adjust equipment to provide efficient operation.

3.04 CLEANING

A. Remove packing materials from equipment and properly discard.

B. Wash and clean equipment.

END OF SECTION

SECTION 23 3813
COMMERCIAL-KITCHEN HOODS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cooking hoods.

B. Condensate (dishwashing) hoods.

1.02 DEFINITIONS

A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type I Hood: A hood designed for grease exhaust applications.

D. Type II Hood: A hood designed for heat and steam removal and for other nongrease applications.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: For the following:
   1. Standard hoods.
   2. Filters/baffles.
   3. Fire-suppression systems.
   4. Lighting fixtures.

C. Shop Drawings: Signed and sealed by a qualified professional engineer.
   1. Shop Drawing Scale: 1/4 inch = 1 foot .
   2. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
   3. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
   4. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
   5. Show control cabinets.
   6. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
   7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   8. Wiring Diagrams: Power, signal, and control wiring.
   9. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.
      a. Piping Diagram Scale: 1/4 inch = 1 foot .

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

1.05 COORDINATION

A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

PART 2 PRODUCTS

2.01 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 304.
   1. Minimum Thickness:
   2. Finish: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.
      a. Finish shall be free from tool and die marks and stretch lines and shall have uniform, directionally textured, polished finish indicated, free of cross scratches. Grain shall run with long dimension of each piece.
   3. Exposed Surfaces: ASTM A 480/A 480M, No. 3 finish (intermediate polished surface).
   4. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 17 7.2600, for use in areas that come in contact with food.
   1. Color: As selected by Architect from manufacturer's full range.
   2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

C. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

D. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and that passes testing according to UL 710.

2.02 GENERAL HOOD FABRICATION REQUIREMENTS

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.
   1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with sheet metal without relying on straps under seams, filling in with solder, or spot welding.
   2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.
   3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.
   4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.
   5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Ventilation Systems & Food Service Equipment Guidelines."

K. Fabricate enclosure panels to ceiling and wall as follows:
   1. Fabricate panels on all exposed side(s) with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.
   2. Wall Offset Spacer: Minimum of 3 inches.

2.03 TYPE I EXHAUST HOOD FABRICATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Accurex.
   2. Avtec.
   3. Halton Company.
   4. Moduserve.

B. Weld all joints exposed to grease with continuous welds, and make filters/baffles or grease extractors and makeup air diffusers easily accessible for cleaning.
   1. Fabricate hoods according to NSF 2, "Food Equipment."
   2. Hoods shall be listed and labeled, according to UL 710, by a testing agency acceptable to authorities having jurisdiction.
   3. Duct Collars: Minimum 0.0598-inch- thick steel at least 3 inches long, continuously welded to top of hood and at corners.

C. Hood Configuration: Exhaust only, (make up air will be supplied directly to the kitchen).

D. Hood Style: Wall-mounted canopy.

E. Filters/Baffles: Removable, stainless-steel. Fabricate stainless steel for filter frame and removable collection cup and pitched trough. Exposed surfaces shall be pitched to drain to collection cup. Filters/baffles shall be tested according to UL 1046, "Grease Filters for Exhaust Ducts," by an NRTL acceptable to authorities having jurisdiction.

F. Lighting Fixtures: Surface-mounted, fluorescent fixtures and lamps with lenses sealed vapor-tight. Wiring shall be installed in conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc at 30 inches above finished floor.
   1. Light switches shall be mounted on front panel of hood canopy.
   2. Lighting Fixtures: Fluorescent with Super T8 light and matching balance complying with UL 1598.

G. Hood Ventilation Controls Systems
   1. Refer to specification section 23 0930 – KITCHEN HOOD VENTILATION CONTROL SYSTEM for requirements of the variable flow ventilation control system.

H. Wet-Chemical Fire-Suppression System
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ansul Incorporated; a Tyco International Ltd. Company.

b. Kidde Fire Systems.
c. Pyro Chem.

2. Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.
   a. Steel Pipe, NPS 2 and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends, chrome plated.
   b. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
   c. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on hood. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
   d. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
   e. Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.
      1) Valve shall close on loss of power.
      2) Valve shall automatically reset on return of power in non-alarm conditions.
   f. Fire-suppression system controls shall be integrated with controls for fans, and fuel supply. Suppression control system and extinguishing agents shall be located in one common single stainless-steel cabinet, (refer to plans for actual location) cabinet shall be as required.
   g. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm and wiring to start fan with fire alarm.

2.04 TYPE II EXHAUST HOOD

A. Condensate Hoods: Provide Type II hoods with all joints and seams liquid-tight.
   1. Inside the bottom perimeter provide an integral formed condensate gutter:
   2. Gutter Dimensions: 3 inches wide with one inch flange turned up at 45 degree angle.
   3. Drain: Stainless steel, one inch diameter, located in back corner of gutter.
   4. Pipe drain to nearest sink drainboard or floor drain.

B. Dishwashing Machine Hoods Type II: Custom-fabricated condensate hood to fit machine.
   1. Make-up and exhaust ducts extending 6 inches above ceiling for connection by others.
   2. Hood Configuration and Size: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

B. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

C. Install hoods to operate free from vibration.

D. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

E. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

F. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

G. Set initial temperatures, and calibrate sensors.

H. Set field-adjustable switches.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect ducts according to requirements in Division 23 Section "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.

C. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:
   1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
   4. Perform hood performance tests required by authorities having jurisdiction.
   5. Perform fire-suppression system performance tests required by authorities having jurisdiction.

C. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 4000
HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Disposable, extended area panel filters.

B. Filter frames and housings.

C. Ultraviolet lights.

1.02 REFERENCE STANDARDS

A. ACGIH - Ultraviolet Radiation: TLV(R) Physical Agents 7th Edition Documentation 2010.

B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).

C. UL 153 - Portable Electric Luminaries Current Edition, Including All Revisions.

D. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.

E. UL 900 - Standard for Air Filter Units Current Edition, Including All Revisions.

F. UL 1598 - Luminaires Current Edition, Including All Revisions.

G. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

C. Shop Drawings: Indicate filter assembly and filter frames, dimensions, motor locations, and electrical characteristics and connection requirements.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Filters: Two sets of each type and size.

1.04 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

A. American Air Filter Company, Inc; _____: www.aafintl.com/#sle.

B. Camfil, a company of the The Camfil Group; _____: www.camfil.us/#sle.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 DISPOSABLE, EXTENDED AREA PANEL FILTERS

A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
   1. Frame: Non-flammable.
   2. Nominal size: 24 by 24 inches.
   3. Nominal thickness: 2 inches.

B. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.

C. Rating, per ASHRAE Std 52.2:
   1. Weight Arrestance: 85 percent.
   2. Initial resistance at 500 fpm face velocity: 0.20 in-wc.

3. Recommended final resistance: 0.9 in-wc.

2.03 FILTER FRAMES AND HOUSINGS

A. General: Fabricate filter frames and supporting structures of 16 gauge, 0.0598 inch galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.

B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size for 24 by 24 inches filter media, minimum 2 inches thick; for extended surface and high efficiency particulate air filters, provide for upstream mounting of panel filters.

C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gauge, 0.0598 inch galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for primary secondary filters with positive sealing gaskets.

2.04 WELDING FUME EXTRACTION / FILTRATION SYSTEM

A. Manufacturers:
1. Airflow Systems Inc; www.airflowsystems.com/air-cleaners

B. Construction:
1. 16 ga. steel cabinet, powder coated.
2. Class II belt-dirven blower, spark-resistant.
3. Side access doors providing access to blower, motor, belt and filters.
4. Motor wired to external junction box.

C. Filtration: Positive sealing filter locking mechanism for all filters with slide in tracks.
1. Prefilters with slide-in rack: 4" pleated.
2. Main Filters: 65% multi-pocket bag type.

D. Required Accessories:
1. Filter pressure gauge kit for each bank.
2. Silencer kit.
3. Filtration: HEPA

2.05 ULTRAVIOLET LIGHTS

A. Manufacturers:
1. Sanuvox Technologies Inc; Biowall: www.sanuvox.com/#sle.
2. Steri-Aire, Inc: www.steril-aire.com/#sle.
3. UV Resources; RLM Xtreme: www.uvresources.com/#sle.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Tested and recognized by UL 153, UL 1598, and UL 1995 for luminaries, heating, and cooling equipment.

C. UV-C Short Wave Light Array Performance: Provide not less than 190 microwatts/sq in.

D. Materials:
1. Provide UV-C resistant polymeric materials or shield from direct or indirect UV-C light with UV-C tolerant material.
2. UV-C Fixtures: Stainless steel to resist corrosion.

E. Lamp Life: 9000 hours minimum with no more than 20 percent loss of output after two years of continuous use.

F. Control Panel: Provide control panel for each UV-C light array.
1. Comply with UL 508A.
2. Use components marked with minimum SCCR (Short Circuit Current Rating).
3. Provide enclosure with NEMA 4X rating for prevention of corrosion and water ingress.

4. Provide control panel with current sensor to indicate status of UV-C array.

G. Safety Features:
   1. Treat view port and other windows to assure UV-C energy emitted is below threshold limit specified by American Conference of Governmental Industrial Hygienists (ACGIH).
   2. Provide mechanical interlock switch to disconnect power to UV-C fixtures when opening access door.
   3. Provide externally mounted, on-off, disconnect, and shutoff switch with lockout/tagout that disconnects UV-C power and prevents unwanted operation of UV-C lights.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

D. UV-C system to be commissioned by manufacturer field representative.

END OF SECTION

SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Type B double wall gas vents.

B. Double wall metal stacks.

C. Special gas venting.

1.02 REFERENCE STANDARDS

A. ANSI Z21.66 - Automatic Damper Devices for Use with Gas-Fired Appliances 2023.

B. NFPA 54 - National Fuel Gas Code 2021.

C. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment 2019.

D. UL 441 - Standard for Gas Vents Current Edition, Including All Revisions.

E. UL 1738 - Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, and IV Current Edition, Including All Revisions.

1.03 DEFINITIONS

A. Breeching: Vent connector.

B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.

C. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.

D. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.

C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory-built units are used.

D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

E. Manufacturer's Certificate: Certify that refractory lined metal stacks meet or exceed specified requirements.

PART 2 PRODUCTS

2.01 TYPE B DOUBLE WALL GAS VENTS

A. Manufacturers:
   1. Amerivent: www.ameri-vent.com/#sle.
   2. Hart & Cooley, LLC: www.hartandcooley.com/#sle.
   3. Selkirk Corporation: www.selkirkcommercial.com/#sle.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Fabrication: Inner pipe of sheet aluminum, and outer pipe of galvanized sheet steel, tested in compliance with UL 441.

C. Electrically Actuated Vent Dampers: Same size as draft hood collar, constructed of stainless steel or galvanized steel, with corrosion-resistant components, in compliance with ANSI Z21.66.

2.02 SPECIAL GAS VENTING (CATEGORY II, III, AND IV)

A. Double-Wall Special Gas Venting:
   1. Manufacturers:
      a. Heatfab Saf-T Vent; Model CI Plus: www.heatfab.com/#sle.
      b. DuraVent.
      c. Hart & Cooley.
   2. Provide double-wall metal stacks, tested to UL 1738 and UL listed with positive pressure rating for use with building heating equipment; comply with NFPA 54.
   3. Fabricate with 1-inch minimum air space between walls and construct inner liner of 28-gauge, 0.015-inch 29-4C stainless steel minimum and outer jacket of 24 gauge, 0.025-inch stainless steel minimum.
      a. Protect aluminized steel surfaces exposed to elements with minimum of one base coat of primer and one finish coat of corrosion-resistant paint suitable for outer jacket skin temperatures of application.
   4. Design, fabricate, and install gastight to prevent products of combustion from leaking into building. Securely connect inner joints and seal in accordance with manufacturer's instructions.
   5. Accessories, UL Labeled:
      a. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers, and storm collar.
      b. Exit Cone: Consists of inner cone and outer jacket to increase stack exit velocity 1.5 times.
      c. Rain/Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. For Type B, double-wall gas vents, maintain UL-listed minimum clearances from combustibles. Assemble pipe and accessories as required for complete installation.

C. Assemble and install stack sections in accordance with NFPA 82, UL Listings, and industry practices. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.

D. Level and plumb chimney and stacks.

3.02 SCHEDULES

A. Breechings, Chimneys and Stacks.
   1. Boiler: Category II, III, or IV in accordance with applicable appliance and intallation.

END OF SECTION

SECTION 23 5216
CONDENSING BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured units.

B. Boiler construction.

C. Boiler trim.

D. Fuel burning system.

E. Factory installed controls.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers 2021.

C. NFPA 54 - National Fuel Gas Code 2021.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittals procedures.

B. Product Data: Provide data indicating general assembly, components, controls, safety controls, and wiring diagrams with electrical characteristics and connection requirements, and service connections.

C. Verification that Contract Documents are in accordance with manufacturer recommendations:
   1. Include with submittal copy of contract documents Hot Water Piping Schematic. Note any modifications required to operate boiler per manufacturer recommendations.
   2. Include with submittal copy of Section 230993 - Sequence of Operations for HVAC. Confirm Sequence of Operations are acceptable to manufacturer, note any required modifications to ensure boiler(s) operate in a manor acceptable to the manufacturer.

D. Manufacturer's Field Reports: Burner manifold gas pressure, percent carbon monoxide (CO), percent oxygen (O), percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide warranty as follows:
   1. Heat Exchanger: 10-year
   2. Burner: 5-year
   3. All other Components: 1-year

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Modular Condensing Hot Water Boiler for Indoor Applications:
   1. Camus Hydronics.
   2. Raypak.
   3. RBI.

2.02 MANUFACTURED UNITS

A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.

B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.

C. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

D. Heat Exchanger: Configuration shall be a cylindrical, vertical, two-pass, counter-flow, fire tube design and consist of an integral combustion chamber with an inner tube bundle for primary heat transfer and an outer tube bundle for extracting latent heat from flue gases. The combustion chamber, fire tubes, and tube sheets shall be constructed of 316L stainless steel. The remainder of the heat exchanger shall be constructed of 304L stainless steel. The fire tubes shall be of an oval design with a minimum wall thickness of 0.061”. The upper and lower tube sheets shall have a thickness of no less than 0.25”. The heat exchanger design shall be capable of 40^{o}F constant system return temperatures and be fully condensing complete with condensate trap and drains.

E. Combustion Chamber: The combustion chamber shall be an all welded stainless-steel construction and an integral part of the heat exchanger. The combustion chamber shall incorporate an easily removable radial fired knitted fiber stainless steel burner to access the internal combustion chamber for inspection, service, and cleaning. A window view port shall be provided for visual inspection of the boiler combustion during firing.

F. Burner: The burner shall be a 100% stainless steel vertical mounted radial fired type with stainless knitted metal fiber construction. The burner shall combust a precise amount of premixed combustion air and gas to provide equal distribution of heat for heat transfer throughout the entire heat exchanger. Combustion products are exhausted under minimum back pressure Combustion operates with a minimum 22:1 turn down ratio while sustaining combustion characteristics throughout the entire modulating range. Operation of up to 99% thermal efficiency and shall be certified for Oxides of Nitrogen (NOx) of 9 ppm corrected to 3% oxygen.

G. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

H. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

I. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

J. Gas Train: The gas train shall consist of a pressure regulating electro-hydraulic proportional air/gas main gas actuator providing a slow opening, fast closing shutoff valve and proportional 1:1 air/gas ratio control, a fast closing safety shutoff gas pressure regulator with 1/2 PSI allowable static pressure, a low gas pressure switch, and a high gas pressure switch. A factory pre-set combination metering valve and orifice shall be provided for setting combustion parameters.

K. Ignition: The ignition module shall employ a direct igniter with 3 tries for ignition followed by lockout. Ignition control shall include times for pre-purge, pre-ignition, ignition, and post purge.

L. Casing:

M. Jacket: External Jacket shall be 430 stainless steel mirror finish panels and a power coated access top cover.

N. Control Compartment Enclosures: NEMA 250, Type 1A.

O. Finish: 430 stainless steel mirror finish.

P. Insulation: Minimum 2-inch- thick, mineral-fiber insulation surrounding the heat exchanger.

Q. Combustion-Air Connections: Inlet and vent duct collars.

R. Mounting base to secure boiler.

S. Characteristics and Capacities: Refer to drawing schedules.

2.03 BOILER TRIM

A. Include devices sized to comply with ANSI B31.1, "Power Piping."

B. Aquastat Controllers: Operating and high limit.

C. Safety Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

E. Boiler Air Vent: Manual.

F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.

2.04 CONTROLS

A. Boilers shall be provided with controls package that will operate all boilers as a common system. BAS contractor will provide boiler control system with a start and stop signal only, the boilers own controls shall preform the following functions:
   1. Determine discharge water temperature based on OA temp and inverse reset schedule. The reset schedule shall be adjustable from a common boiler control panel.
      a. Boiler manufacture shall provide and install exterior temperature sensor. Temperature sensor shall be located in adjacent exterior area way. Control wiring from sensor to boiler shall be installed in conduit.
   2. Determine individual boiler operation dependent on building load and flow.
   3. Rotate boilers on a lead/lag basis to equalize run time among boilers.
   4. Start/stop boilers individual primary water pumps based on building load and operations.
   5. Boiler manufacture shall provide all hydronic temperature sensor required for proper operation of boiler. Coordinate required installation locations with contractor. Control wiring shall be installed in conduit.

B. BAS Interface: Factory installed hardware and software to enable building automation system to monitor and display boiler status and alarm.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual -reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.

D. ASME CSD-1 Control Requirements: Provide all control accessories as required to meet ASME CSD-1 requirements including but not limited to the following.
1. Low Water Cutoff Swtich. Low water cut-off switch shall be 120V, provide power from the boiler circuit.
2. Flow Switch.
3. High Pressure Gas Switch
4. Low Pressure Gas Switch

E. Isolation Control Valve: Provide motorized butterfly isolation control valve for each boiler.
1. Valve shall be controlled by boilers own logic. Provide control wiring as required between valve and boiler controller.
2. Valve shall be 24V, powered open, spring closed. 24V power for control valve shall be from boiler, if boiler manufacture can not provide 24V power, provide 120V power accordingly.
3. Valve shall be lined size and shall be control by the boilers own logic. 24V to be powered from the boiler, Power-Open, Spring-Closed.

2.05 GAS VENTING

A. The boiler manufacture shall provide and size the appropriate UL listed boiler breaching system including all required accessories including but not limited to roof thimble, exit conde, rain/stack cap, etc.. Construction to be AL29-4C inner wall, stainless steel outer wall.

2.06 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to fused disconnect switch.
5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
6. Provide each motor with overcurrent protection.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.

C. Install boiler isolation control valve and associated power and control wiring. Control and power wiring between boiler and valve shall be in conduit, lose wires is not acceptable.

D. Install boiler outdoor air sensor and associated control wiring between sensor and boiler controller.

E. Intstall boiler CO sensor and associated control wiring.

F. Install boiler on concrete housekeeping base, sized minimum of 4 inches larger than boiler base in accordance with Section 03 3000.

G. Pipe relief valves to nearest floor drain.

H. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

I. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface, see Section 23 0900 & 23 0993.

3.02 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Demonstrate proper operation of equipment to Owner's designated representative.

D. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.

END OF SECTION

SECTION 23 6416
CENTRIFUGAL WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Centrifugal water chiller.

1.02 RELATED REQUIREMENTS

A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.

B. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

A. AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle 2023.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2022, with Errata (2023).

C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata (2023).

E. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2023.

F. IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems 2022.

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. UL 508 - Industrial Control Equipment Current Edition, Including All Revisions.

I. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.

D. Verifications that Contract Documents are in accodance with manufacturer recommendations:
   1. Include with submittal copy of contract documents chilled water piping schematic. Note any modifications required to operate chiller per manufacturer recommendations.
   2. Include with submittal copy of Section 230993 - Sequence of Operations for HVAC. Confirm Sequence of Operations are acceptable to manufacture, note any required modifications to ensure chiller(s) operate in manor acceptable to the manufacturer.

E. Manufacturer's Certificate: Certify that components of package not furnished by manufacturer have been selected in accordance with manufacturer's requirements.

F. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

G. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble- shooting guide.

H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within specified warranty period. Warranty indicated shall be independent of acceptance of any Maintenance Agreement accepted.
   1. Extended warranties include, but are not limited to, the following:
      a. The manufacturer shall provide a five year parts warranty for the entire compressor assembly. Include coverage for compressor casting, compressor motor, impellers, speed increasing gears, inlet guide vanes, bearings, shafts, motor alignment, gaskets and O-rings, suction elbow and discharge volute. Any refrigerant or at the shaft seal shall be repaired at no cost to the owner. The warranty shall commence at date of substantial completion.
      b. The manufacturer shall provide a five year parts and labor warranty for the complete chiller assembly including structural frame, compressor motor starter and/or variable speed drive, compressor, compressor motor, speed increasing gears, purge (low pressure chillers), condenser and evaporator tube bundles and tubes, control panel, chiller controls and safeties, microprocessor boards, gauges, water boxes, refrigerant relief valves (medium and high pressure chillers), and rupture disks (low pressure chillers). The warranty shall commence at date of substantial completion.
   2. The manufacturer shall provide 5-year replacement refrigerant charge warranty.

C. Warranty Period: Five years from date of Substantial Completion. Manufacturers and/or their vendors are requried to cover the added warranty cost between the time of delivery/start-up and substaintial completion, chillers manufacturer and or their vendors not covering this cost will not be accepted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Corporation, (Alternate 3a)

B. Trane Technologies, (Alternate 3b)

C. Substitutions: See Section 01 6000 - Product Requirements.
   1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.
   2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Architect that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
   3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

2.02 CENTRIFUGAL WATER CHILLER

A. Refer to drawing schedule for capacity requirements.

B. Factory assembled and tested, packaged, water cooled chillers consisting of centrifugal compressors, compressor motor, condenser, evaporator, refrigeration accessories, instrument and control panel including gauges and indicating lights, auxiliary components and accessories, and motor starters.

1. Rating: Comply with AHRI 550/590 (I-P).
2. Safety: Comply with UL 1995.
3. Comply with ASME BPVC-VIII-1 for construction and testing of centrifugal chillers.
4. Comply with ASHRAE Std 15 for safe construction and operation of centrifugal chillers.

C. Refrigeration:
   1. Refrigerant:
      a. Type: R-134a or R1233zd; ASHRAE 34, Class A1.
      b. Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
   2. Refrigerant Flow Control: Manufacturer's standard refrigerant flow-control device satisfying performance requirements indicated.
   3. Pressure Relief Device:
      a. Comply with requirements in ASHRAE 15 and in applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
      b. For Chillers Using R-134a or R-1233zd: ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Condenser shall have dual valves with one being redundant and configured to allow either valve to be replaced without loss of refrigerant.
   4. Refrigeration Transfer: Provide service valves and other factory-installed accessories required to facilitate transfer of refrigerant from chiller to a remote refrigerant storage and recycling system. Comply with requirements in ASHRAE 15 and ASHRAE 147.
   5. Purge System: (Applicable to negative pressure refrigerant machines only)
      a. System shall be a thermal purge design, refrigerant or air cooled, equipped with a carbon filter that includes an automatic regeneration cycle.
      b. Factory wire to chiller's main power supply and system complete with controls, piping, and refrigerant valves to isolate the purge system from the chiller.
      c. Construct components of noncorrodible materials.
      d. Controls shall interface with chiller control panel to indicate modes of operation, set points, data reports, diagnostics, and alarms.
      e. Efficiency of not more than 1 lb of refrigerant per pound of air when rated according to ARI 580.
      f. Operation independent of chiller per ASHRAE 147.

D. Energy Efficiency: ASHRAE Std 90.1.
   1. Refer to drawings for minimum efficiency requirements.

E. Evaporator Side:
   1. Provide evaporator of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Position intermediate tube support sheets along length of shell to avoid contact and relative motion between adjacent tubes.
   2. Test and, where applicable, stamp refrigerant side for 45 psi working pressure and water side for 150 psi working pressure, in accordance with ASME BPVC-VIII-1.
   3. Insulate evaporator and cold surfaces with 0.75 inch minimum thick flexible expanded polyvinyl chloride insulation with maximum K factor of 0.28.
   4. Provide thermometer wells or thermistors for temperature controller and low temperature cutout.
   5. Design and construct evaporator to prevent liquid refrigerant from entering the compressor.
   6. Provide carbon rupture disc or relief valve on shell in accordance with ASHRAE Std 15.
   7. Construction and materials to comply with ASME BPVC-VIII-1 or ASHRAE Std 15 as applicable to chiller manufacturer and chiller model.
   8. Minimum Wall Thickness: 0.028" at intermediate tube supports.

F. Condenser Side:
   1. Provide condensers of shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper tubes or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Position intermediate tube support sheets along shell length to avoid contact and relative motion between adjacent tubes.
   2. Test and, where applicable, stamp refrigerant side for 45 psi working pressure and water side for 150 psi working pressure, in accordance with ASME BPVC-VIII-1.
   3. Provide carbon rupture disc or relief valve on shell in accordance with ASHRAE Std 15.
   4. Provide baffles to ensure even distribution of incoming gas and to concentrate noncondensible gases.
   5. Construction and materials to comply with ASME BPVC-VIII-1.
   6. Minimum Wall Thickness: 0.035" at intermediate tube supports.

G. Purge System:
   1. Provide purge system on positive pressure units, incorporating a low temperature refrigeration system to automatically remove noncondensibles, water and air.
   2. Limit system discharge to maximum of 0.60 pound of refrigerant per pound of air discharged.

H. Centrifugal Compressor:
   1. Compressors (Requiring Oil): Single-stage or multistage, variable-displacement, integral variable frequency controller, and digital electronic controls.
   2. Compressors (Maginet/Oil Less Type): Single-stage or multistage, variable-displacement, magnetic bearing centrifugal-type compressor driven by an electric motor(s) using oil-free compressor technology using, magnetic bearings, integral variable frequency controller, and digital electronic controls.
   3. Compressor Casing: Cast iron, horizontally or vertically split with machined passages and leak tested to 45 psi. Provide refrigerant sight glass.
   4. Impellers: Single or multi-stage, in-line design, fully shrouded, statically and dynamically balanced, tested to 20 percent over operating speed, mounted on heat treated forged or rolled steel shaft, nonferrous, labyrinth seals between stages.
   5. Bearings: Steel or aluminum journal bearings, pressure lubricated.
   6. Gear Box: Double helical design, symmetrical and center supported by spherically seated, self-aligning bearing, arranged for inspection without disassembly.
   7. Motor: Hermetically sealed, single speed, low slip induction type; see Section 23 0513.
   8. Lubrication: Oil pump, with oil cooler, pressure regulator, oil filters, thermostatically controlled oil heater, and motor controls. Interlock to start before chiller motor and run after motor is shut down. Provide sight glass or electronic sensors for monitoring oil level.
   9. Lubrication System:
      a. Force-feed oil to all bearings, gears and rotating surfaces
      b. Oil reservoir: designed in accordance with ASME; contains oil pump and oil heater
      c. Oil pump: positive-displacement type, submerged in oil reservoir.
      d. Oil filter: single filter or dual filter, externally mounted, ½ micron, replaceable cartridge, with service valves
      e. Oil return system: oil eductor to recover and return oil in the evaporator to the main oil sump.
      f. Oil cooler: refrigerant cooled, factory mounted, factory piped and pressure tested
      g. Oil heater: immersion type or belly band type, thermostatically controlled
      h. Oil temperature: sense via thermocouple located between bearing pads
      i. Pump operation: automatically operate oil pump for 50 seconds (minimum) prior to startup. Prevent start¬up until operating oil pressure is established via an interlock with the control panel. Maintain pressure during compressor coastdown, and for 2 minutes (minimum) after coastdown.

j. Means of lubrication after power failure during coast down of driveline. A gravity-fed oil reservoir or a UPS / battery backup to oil pump or a shaft-driven oil pump are acceptable.

10. Refrigerant: Factory precharge unit with refrigerant specified above.

I. Electrical Starters and Drives, Low Voltage (208 to 600 VAC):

1. Water-Cooled, Unit-Mounted Variable Frequency Drive (VFD):

a. Specifically design VFD to interface with the centrifugal water chiller controls and allow for the operating ranges and specific characteristics of the chiller. VFD-control logic is to optimize chiller efficiency by coordinating compressor motor speed and compressor inlet guide vane position to maintain the chilled water setpoint while avoiding surge. If surge is detected, VFD is to move away from and avoid surge at similar conditions in the future.

b. Efficiency: 97 percent or better at full speed and full load.

c. Fundamental Displacement Power Factor: Minimum of 0.97.

d. Provide voltage and current regulated, solid state, microprocessor-based pulse-width modulated (PWM). Output power devices to be IGBT transistors.

e. Provide liquid- or air-cooled heatsink to cool power semiconductor and capacitor.

f. House VFD in NEMA Type 1 metal enclosure having a minimum short circuit withstand rating of 65,000 amps per UL 508. Include three phase input lugs plus a grounding lug for electrical connections, output motor connection via factory installed bus bars and components properly segregated and completely enclosed in a single metal enclosure.

1) Enclosure to include padlockable, door-mounted circuit breaker with minimum AIC rating of 65,000 amps.

2) Entire chiller package to be listed by Underwriter's Laboratories Inc.

g. Test VFD according to UL 508 and listed by a National Recognized Testing Laboratory (NRTL) as designated by OSHA.

h. Active Harmonic Distortion Filter: Factory mounted and wired, IEEE 519 compliant. Maximum of 5% total harmonic distortion. All losses associated with the harmonic filter shall be incorporated into the chiller’s efficiency. Passive filters are not acceptable.

i. Line Frequency: 38 to 60 Hertz with plus or minus 10 percent tolerance.

j. VFD is to include the following features:

1) Control circuit voltages physically and electrically isolated from power circuit voltage.

2) 150 percent instantaneous torque available for improved surge control.

3) Soft start, adjustable linear acceleration, coast-to-stop.

4) Adjustable current limiting and UL-approved electronic motor overload protection.

5) Insensitivity to incoming power phase sequence.

6) VFD and motor protection from the following faults:

(a) Output line-to-line short circuit.

(b) Line-to-ground short circuit.

(c) Phase loss at AFD input.

(d) Phase reversal/imbalance.

(e) Over-voltage.

(f) Under-voltage.

(g) Over-temperature.

k. VFD Status Indicators:

1) Output speed in hertz and rpm.

2) Input line voltage.

3) Input line kW.
4) Output/load amps.
5) Average current in percent RLA.
6) Load power factor.
7) Fault.
8) VFD transistor temperature.

l. Service Conditions:
1) Operating Ambient Temperature: 14 to 104 degrees F.
2) Room Ambient Relative Humidity: Up to 95 percent.
3) Elevation: Up to 3,300 feet. For every 3,300 feet above 3,300 feet, decrease the rated output current by 4 percent up to 9,900 feet.

J. Controls Package:
1. Unit Controls: Factory-supplied DDC:
a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; Section 23 0993.
2. Disconnect Switch: Factory mount disconnect switch in starter control panel.
3. On or near chiller, provide microprocessor based control panel containing solid state, fully automatic operating and safety controls.
4. Provide the following manufacturer's standard safety controls, including the following minimum functions, so that operating any one will shut down machine and require manual reset:
a. Low evaporator refrigerant temperature.
b. High condenser refrigerant pressure.
c. Low oil pressure.
d. Low refrigerant evaporator pressure.
5. Provide the manufacturer's standard safety controls arranged so that operating any one will shut down machine and automatically reset.
6. Provide the following devices on control panel:
a. Manual Switches:
1) Machine off-auto switch.
2) Oil pump switch, manual or automatic.
3) Purge pump switch, manual-off-auto.
4) Machine selector switch to allow load, unload, hold or automatic operation.
b. Manual Setpoint Adjustments:
1) Leaving chilled water temperature.
2) Current demand limit.
c. Status Lights:
1) Chilled water flow proven.

2) Cooling required.
3) Unit running.
4) Unit loading.
5) Unit unloading.
6) Manual reset required.
7) Remote chilled water setpoint active.
8) Remote current water setpoint active.

d. Setpoint and Temperature Display:
1) Chilled water setpoint.
2) Current limit setpoint.
3) Entering evaporator water temperature.
4) Leaving evaporator water temperature.
5) Entering condenser water temperature.
6) Leaving condenser water temperature.

7. Provide the following operating controls:
a. Solid state, chilled water temperature controller that controls electronic guide vane operator and hot gas bypass. Locate temperature sensor in entering chilled water.
b. Adjustable thirty minute off timer prevents compressor from short cycling.
c. Demand limit device to manually set maximum current infinitely between 40 percent and 100 percent of full load amperes.
d. Automatic start that determines demand for chilled water from proof of chilled water flow and temperature differential between chilled water setpoint and supply temperature.
e. Head pressure control via manufacture provided head pressure control valve.

K. Electrical:
1. Compliance: NEMA 250 or UL 1995 as applicable.

L. Accessories:
1. Head Pressure Control Valve: Required for Carrier chillers only
a. Provide at each chiller and install per manufacture recommendations.
b. Automated butterfly valves with high resolution, fast acting actuator.
c. Valve shall be designed for chiller head pressure control applications.
d. Valve Features:
1) EDPM rubber liner.
2) Alum bronze or nylon coated disc.
3) Stainless steel shaft.
4) Full threaded lug.

2. Flow Switches: Chiller manufacturer shall furnish a factory mounted and wired thermal dispersion flow switch for each evaporator and condenser water nozzle and verify field-mounting location before installation.
3. Vibration Isolation:
a. Chiller manufacturer shall furnish vibration isolation for each chiller.
b. Neoprene Pad:
1) Two layers of 0.375-inch-thick, ribbed- or waffle-pattern neoprene pads separated by a 16-gage, stainless-steel plate.
c. Fabricate pads from 40- to 50-durometer neoprene.
d. Provide stainless-steel square bearing plate to load the pad uniformly between 20 and 40 psig with a 0.12- to 0.16-inch deflection.

2.03 REFRIGERANT MONITORING AND EMERGENCY VENTILATION CONTROL

A. General: Provide complete refrigerant monitoring and ventilation fan control system. Control systems shall include but not be limited to the following:

1. Honeywell 301EM mechanical room controller with built in audio and visual alarm. Provide with controls power transfer unit can not operate at 120V.
2. Honeywell 301IRFS Infrared Refrigerant Gas Detectors.
3. Glass Break warning switches installed at each mechanical room door.

B. All controllers, devices and sensors shall seamlessly intergrate. On detection of refrigerant, an audio visual warning shall be provided, the emergency exhaust fan shall start and OA louver shall open.

2.04 REFRIGERANT RECOVERY AND STORAGE SYSTEM

A. Include cost associated with Refrigerant Recovery and Storage system under Alternate 5.

B. General: Provide refrigerant recovery system for high pressure refrigerants that combines air-cooled vacuum pump and ASME recovery tank hard piped on common steel frame mounted on casters.

C. Manufacturer: RefTec, model LRH-115-A-500 or approved equal.

D. Storage Capacity: 4,000-lb of R134a at 80% capacity.

E. Vacuum Pump:
1. Electrical: 2hp/115v/60hz/1-phase
2. Push/Pull (R22): 81-lbs/min
3. Vapor (R22): 2.14-lb/min
4. Final Vacuum: 15-in HG

F. Additional Requirements:
1. Dual 250-psi relief valves on diverting valve.
2. Low pressure (15" Hg) cut-off switch.
3. 3-site glasses on tank.
4. 80% tank full float switch and 6' cable.
5. ETL Certified.
6. 50-ft power cord for controls and unit.
7. Bottom drain connection
8. Hoses:
   a. One (1) 10-ft, 1/2" diameter with ball valve
   b. Two (2) 20-ft, 1/2" diameter hose with ball valves

2.05 TUBE BUNDLE BRUSHING MACHINE

A. Include cost associated with Tube Bundle Brushing Machine under Alternate 5.

B. General: Portable industrial designed, rotary tube cleaning kit sized for condenser and evaporator tube bundle.

C. Product Requirements:
1. Quick-connect shafts and brushes.
2. Motor Power: 0.25HP/115V/1-phase.
3. Power Cord: 12-ft.
4. Input Power: 5.5-amp.
5. Water Input: 2-gpm at 30-psi

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install chiller head pressure control valve per manufacturer's instructions and install control wiring between control valve and chiller control panel.

C. Provide for connection to electrical service.

D. Provide for connection of electrical wiring between starter and chiller control panel, oil pump, and purge unit.

E. Install units on vibration isolation.

F. Provide evaporator connections to chilled water piping. Refer to piping diagrams for all requirements.

G. Furnish and install necessary auxiliary water piping for oil cooling units and purge condensers.

H. Insulate evaporator and cold surfaces.

I. Provide condenser connection to condenser water piping.

J. Arrange piping for easy dismantling to permit tube cleaning.

K. Provide piping from chiller rupture disc to outdoors. Size as recommended by manufacturer.

L. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end BAS software.

M. Install refrigerant monitoring system. Install interlock wiring between devieces in conduit as required for a fully functioning system.

3.02 SYSTEM STARTUP

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Provide services of factory trained representative for minimum of as required to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, and calibrate controls.

D. Supply initial charge of refrigerant and oil.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. See Section 01 7900 - Demonstration and Training for additional requirements.

C. Train operating personnel in operation and maintenance of units.

D. Provide the services of the manufacturer's field representative to conduct training.

END OF SECTION

SECTION 23 6514
INDUCED-DRAFT COOLING TOWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Induced-draft , cross flow type cooling towers.

1.02 RELATED REQUIREMENTS

A. Section 22 1005 - Plumbing Piping.

B. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

A. ASME PTC 23 - Atmospheric Water Cooling Equipment 2003 (Reaffirmed 2014).

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide rated capacities, dimensions, weights and point loadings, accessories, required clearances, electrical requirements and wiring diagrams, and location and size of field connections. Submit schematic indicating capacity controls.

C. Shop Drawings: Indicate suggested structural steel supports including dimensions, sizes, and locations for mounting bolt holes.

D. Manufacturer's Certificate: Certify that cooling tower performance, based on ASME PTC 23, meets or exceeds specified requirements and submit performance curve plotting leaving water temperature against wet bulb temperature.

E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.

F. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, and accessories.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Factory assemble unit. For shipping, disassemble into as large as practical sub-assemblies so that minimum amount of field work is required for re-assembly.

B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. The entire tower, including structure, casing, basins, decking, fan(s), motor(s), and all mechanical drive components shall be warranted against failure due to defects in materials and workmanship for a period of five (5) years from the date of substantial completion. Manufacturers and/or their vendors are required to cover the warranty cost between the time of delivery/start-up and substantial completion, towers not covered by a warranty of this scope will not be accepted.

PART 2 PRODUCTS

2.01 INDUCFED DRAFT CROSSFLOW COOLING TOWER

A. Tower Base:

1. Provide an induced draft, crossflow type, factory assembled, film fill, industrial duty, stainless steel cooling tower situated as shown on the plans. Refer to plans for the limiting overall dimensions of the tower. Total operating power of all fans shall not exceed scheduled HP on drawings. Tower shall be similar and equal in all respects to Marley NC Series.
2. The cooling tower shall be designed for quiet operation, refer to drawing schedule for maximum sound levels. Sound levels shall be independently verified by a CTI-licensed sound test agency to ensure validity and reliability of the manufacturers published values. Measurement and analysis of the sound levels shall be conducted by a certified Professional Engineer in Acoustical Engineering. Sound pressure levels shall be measured and recorded in the acoustic near-field and far-field locations using ANSI S1.4 Type 1 precision instrumentation and in full conformance with CTI ATC-128 test code published by the Cooling Technology Institute (CTI). All low sound options shall be CTI certified for thermal performance.

B. Thermal Performance:
1. Refer to drawing schedule for minimum Thermal Performance requrements. The tower's thermal rating shall be Certified by the Cooling Technology Institute.
2. The tower shall be capable of a minimum 56.332 gpm/Hp efficiency per ASHRAE Standard 90.1.
3. CTI Certification notwithstanding, the cooling tower manufacturer shall guarantee that the tower supplied will meet the specified performance conditions when the tower is installed according to plan. If, because of a suspected thermal performance deficiency, the owner chooses to conduct an on-site thermal performance test under the supervision of a qualified, disinterested third party in accordance with CTI or ASME standards during the first year of operation; and if the tower fails to perform within the limits of test tolerance; then the cooling tower manufacturer will pay for the cost of the test and will make such corrections as are appropriate and agreeable to the owner to compensate for the performance deficiency.

C. Design Loading:
1. The tower structure, anchorage and all its components shall be designed by licensed professional engineers, employed by the manufacturer, per the International Building Code to withstand a wind load of 30 psf, as well as a 0.3g seismic load. The fan deck, hot-water basin covers and, where specified, maintenance platforms shall be designed for 60 psf live load or a 200 lb concentrated load. Guardrails, where specified, shall be capable of withstanding a 200 lb concentrated live load in any direction, and shall be designed in accordance with OSHA guidelines.
2. The tower shall be structurally capable of being supported at the four outer corners of the tower cell. Alternatively, the tower manufacturer shall provide supporting steel to adapt tower to be supported at four outer corners.

D. Construction:
1. Except where otherwise specified, all components of the cooling tower shall be fabricated of series 301L stainless steel. The tower shall be capable of withstanding water having a chloride content (NaCl) up to 750 ppm; a sulfate content (SO4) up to 1200 ppm; a calcium content (CaCO3) up to 800 ppm; and silica (SiO2) up to 150 ppm. The circulating water shall contain no oil, grease, fatty acids, or organic solvents.
2. Fiberglass casing, polyurethane barriers, and thermosetting hybrids and the components they are adhered to shall be considered non-recyclable and not allowed.

3. The specifications, as written, are intended to indicate those materials that will be capable of withstanding the above water quality in continuing service, as well as the loads described in paragraph 4.1. They are to be regarded as minimum requirements. Where component materials peculiar to individual tower designs are not specified, the manufacturers shall take the above water quality and load carrying capabilities into account in the selection of their materials of manufacture.
4. The tower shall be listed in the current FM Approval Guide (approvalguide.com) and conform to the FM Approval Standard for Cooling Towers, Class Number 4930 that is approved for use without sprinkler systems. The tower shall have successfully passed full scale fire testing, static and cyclic wind pressure testing, large missile impact testing (for Zone HM), and structural design evaluation as administered by FM-Approvals. The tower shall be capable of +70/-140 psf for Zone H as defined by FM Global. A copy of the FM Approval Certificate of Compliance, dated November 2013 or later shall be available upon request.

E. Mechanical Equipment:
1. Fan(s) shall be propeller-type, incorporating aluminum alloy blades attached to galvanized hubs with U-bolts. Blades shall be individually adjustable. Maximum fan tip speed shall be 13,000 ft/min. Fan(s) shall be driven through a right angle, industrial duty, oil lubricated, geared speed reducer that requires no oil changes for the first five (5) years of operation. All gearbox bearings shall be rated at an L10A service life of 100,000 hours or greater and the gear sets shall have AGMA Quality Class of 9 or greater. The gearbox shall include any modifications to enable operation down to 10% of full speed.
2. An external oil level dipstick shall be located adjacent to the motor at the fan deck surface and shall be accessible from a portable maintenance ladder.
3. Single-speed motor(s) shall be sized per the drawing schedule, NEMA Premium Efficiency, TEFC, 1.15 service factor, inverter duty, variable torque, and specially insulated for cooling tower duty (Class F). Speed and electrical characteristics shall be 1800 rpm, single-winding, 3-phase, 60 Hz, 460/208 volts. Motor shall operate in the shaft-horizontal position for geardrive towers and shaft-down position for belt drive towers. Nameplate horsepower shall not be exceeded at design operation.
4. Motor shall be mounted outside the casing of the tower, and shall be connected to the gear reducer by a dynamically balanced, stainless steel tube and flanged driveshaft.
5. The complete mechanical equipment assembly for each cell shall be supported by two horizontal steel beams that resist misalignment between the motor and the gear reducer/ belt drive system.
6. A vibration limit switch in a NEMA 4X housing shall be installed on the mechanical equipment support and wired to the shutdown circuit of the fan motor starter or VFD. The purpose of this switch will be to interrupt control power voltage to a safety circuit in the event of excessive vibration causing the starter or VFD equipment to de-energize the motor. It shall be adjustable for sensitivity, and include a means to reset the switch.
7. Include ultrasonic oil level switch and required accessories to allow monitoring by BAS.

F. Fill, Louvers & Drift Eliminators:
1. Fill shall be film type, thermoformed of PVC, with louvers and eliminators formed as part of each fill sheet. Fill shall be suspended from stainless steel structural tubing supported from the tower structure, and shall be elevated above the floor of the cold-water basin to facilitate cleaning. Air inlet faces of the tower shall be free of water splash out.

G. Drift eliminators shall be PVC, triple-pass, and shall limit drift losses to 0.005% or less of the design water flow rate.

H. Hot Water Distribution System:

1. Two open stainless steel basins (one above each bank of fill) shall receive hot water piped to each cell of the tower. These basin components shall be installed and sealed at the factory and assembled with bolted connections. Tap screws shall not be allowed due to their potential to develop leaks. The basins shall be equipped with removable, stainless steel covers capable of withstanding the loads described in Designed Loading paragraph. The water distribution system shall be accessible and maintainable during tower fan and water operation.
2. Each cell of the tower shall include a single hot-water inlet connection located as shown on the plans. An internal system of PVC piping shall deliver water equally to the distribution basins without the need for balancing valves. This internal piping system shall require no scheduled maintenance, and shall be located such that it does not interfere with normal maintenance access. The internal piping shall extend to the exterior surface of the tower.
3. The water distribution system shall be accessible and maintainable while tower is operating.

I. Casing, Fan Deck and Fan Cylinder:
1. The casing and fan deck shall be stainless steel, and shall be capable of withstanding the loads described in design loading paragraph. The top of the fan shall be equipped with a conical, non-sagging, removable fan guard, fabricated of welded 5/16" and 7 gauge rods, and hot dip galvanized after fabrication. Fan cylinders 5'-0" in height and over shall not be required to have a fan guard.

J. Cold Water Collection Basin:
1. The collection basin shall be welded 301L stainless steel construction. Only low-carbon stainless steel alloys will be accepted in order to minimize the risk of intergranular corrosion in the weld zones. The basin shall include the number and type of suction connections required to accommodate the outflow piping system shown on the plans. Suction connections shall be equipped with stainless steel debris screens. An overflow and drain connection shall be provided in each cell of the cooling tower. The basin floor shall slope toward the drain to allow complete flush out of debris and silt that may accumulate. Towers of more than one cell shall include a method for flow and equalization between cells. The basin shall be accessible and maintainable while water is circulating. All steel items that project into the basin shall also be made of stainless steel.
2. A hole and bolt circle shall be provided in the depressed section of the basin for equalizer piping between cells. A full-face, .25" thick, 50 durometer gasket shall be provided at each equalizer location.

K. Access:
1. Provide a ladder extension for connection to the foot of the ladder attached to the tower casing. This extension shall be long enough to rise from the roof (grade) level to the base of the tower. The installing contractor shall be responsible for cutting the ladder to length; attaching it to the foot of the tower ladder; and anchoring it at its base.
2. 10.1 A large stainless steel, rectangular access door shall be located on both cased faces for entry into the cold-water basin. Doors shall provide convenient access to the fan plenum area to facilitate inspection and allow maintenance to the fan drive system. The access doors shall be at least 30" wide by 48" high.
3. The top of the tower shall be equipped with a guardrail complete with kneerail and toeboard, designed according to OSHA guidelines and factory welded into subassemblies for ease of field installation. Posts, toprails and kneerails shall be 1.5" square tubing. The guardrail assembly shall be hot dipped galvanized after welding and capable of withstanding a 200 pound concentrated live load in any direction. Posts shall be spaced on centers of 8'-0" or less. A 1'-6" wide aluminum ladder with 3" I-beam side rails and 1.25" diameter rungs shall be permanently attached to the endwall casing of the tower, rising from the base of the tower to the top of the guardrail.

4. A heavy gauge aluminum safety cage, welded into subassemblies for ease of field installation, shall surround the ladder, extending from a point approximately 7'-0" above the foot of the ladder to the top of the guardrail. Maximum weight of welded subassemblies shall not exceed 20 lb for ease of installation.
5. There shall be an access platform at the base of the tower extending from the vertical ladder to the access door. The platform shall be surrounded by an OSHA compliant guardrail system welded into subassemblies for ease of installation. The walking surface of the platform shall be perforated to provide a non-slip surface for personnel safety.
6. Provide a factory-installed, walkway extending from one cased-face access door to the other cased face. A steel framework shall support the walkway and the top of the walkway shall be at or above the cold-water basin overflow level. The walkway and framework to be equivalent material as the tower basin and have a minimum width of 36".
7. A factory-installed, elevated platform convenient for the care and maintenance of the tower's mechanical equipment shall be provided. The walkway and framework to be equivalent material as the tower basin.
8. Provide basin equalizer connections, refer to drawings for sizing.

L. Electric Immersion Heaters
1. In pan, suitable to maintain temperature of water in pan at 42 degrees F when outside temperature is 15 degrees F and wind velocity is 15 mph; immersion thermostat and float control operate heaters on low temperature when pan is filled.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install tower on structural steel beams as instructed by manufacturer.

C. Connect condenser water piping with flanged connections to tower. Pitch condenser water supply to tower and condenser water suction away from tower. See Section 23 2113.

D. Connect make-up water piping with flanged or union connections to tower. Pitch to tower. See Section 22 1005.

E. Connect overflow, bleed, and drain, to floor drain.

3.02 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements for additional requirements.

B. Provide the services of the manufacturer's field representative to inspect tower after installation and submit report prior to start-up, verifying installation is in accordance with specifications and manufacturer's recommendations.

END OF SECTION

SECTION 23 7313
MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Casing construction.
B. Fan section.
C. Coil section.
D. U-Frame Dehumidifer Heat Pipes.
E. Filter and air cleaner section.
F. Damper section.
G. Total energy recovery wheel section.
H. Ultraviolet lights.
I. Access section.

1.02 RELATED REQUIREMENTS

A. Section 23 3416 - Centrifugal HVAC Fans.

1.03 REFERENCE STANDARDS

A. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014 (Reaffirmed 2020).
B. ACGIH - Ultraviolet Radiation: TLV(R) Physical Agents 7th Edition Documentation 2010.
C. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
D. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment 2018.
E. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program 2015.
F. AMCA 99 - Standards Handbook 2016.
G. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating 2016.
H. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
I. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2022.
J. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Addendum (2022).
K. ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating 2011 (Reapproved 2021).
L. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.
N. UL (DIR) - Online Certifications Directory Current Edition.
O. UL 153 - Portable Electric Luminaries Current Edition, Including All Revisions.
P. UL 508A - Industrial Control Panels Current Edition, Including All Revisions.
Q. UL 1598 - Luminaires Current Edition, Including All Revisions.
R. UL 1812 - Ducted Heat Recovery Ventilators Current Edition, Including All Revisions.

S. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data:
   1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
   2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
   3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
   4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
   5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Include installation instructions.

E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 6000 - Product Requirements for additional provisions.
   2. Extra Filters: Two sets for each unit.
   3. Extra Motors:
      a. Provide Two spare Fan motors for each frame size and horsepower motor used on the project.
      b. Provide One spare Energy Recovery motor for each size and horsepower motor used on the project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.06 WARRANTY

A. See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B. Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carrier Global Corporation: Alternate 4a.

B. Trane Technologies, PLC: Alternate 4b.

C. Substitutions: See Section 01 6000 - Product Requirements.

2.02 REGULATORY REQUIREMENTS

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.03 CASING CONSTRUCTION

A. Full Perimeter Base Rail:
   1. Construct of galvanized steel.
   2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.

B. Casing:
   1. Forming: Form walls, roofs, and floors with at least two breaks at each joint. Provide 2" double wall construction on all walls, doors, roofs and floors. Provide 20 gauge exterior and 20 gauge interior foam filled panels. Provide minimum 16 gauge interior and 20 gauge foam filled exterior galvanized steel floor. Units shall be designed and constructed such that all exterior panels are non-load bearing.
   2. Provide mid-span, no through metal, internal thermal break.
   3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
   4. Casing Air Pressure Performance Requirements:
      a. Able to withstand up to 8 in-wc positive or negative static pressure.
      b. Not to exceed 0.0042 inches per inch deflection at 8 in-wc in positive pressure sections and minus 8 in-wc in negative pressure sections.
   5. Apply manufacturer's standard coating immediately after cleaning and pretreating, un-coated galvanized steel is not acceptable.
   6. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1

C. Casing Insulation and Adhesive:
   1. Insulation: ASTM C 1071, Type II, 2" thick 3 pound or 2" foam filled R-12.
   2. Location and Application: Encased between outside and inside casing.

D. Access Doors:
   1. Construction, thermal and air pressure performance same as casing.
   2. Doors shall be provided with neoprene gaskets, applied around entire perimeter of the panel frames.
   3. Provide surface mounted handles on hinged, swing doors.
   4. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
   5. Provide Access Doors in the Following Locations:
      a. Fan section.
      b. Access sections.
      c. Coil sections.
      d. Filter sections.
      e. Mixing sections.

E. Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at 8 in-wc positive or negative static pressure.

F. Insulation:
   1. Foam filled, provide minimum thermal thickness of 12 R throughout.
   2. Completely fill panel cavities in each direction to prevent voids and settling.
   3. Comply with NFPA 90A.

G. Drain Pan Construction:

1. Provide cooling coil and humidifier sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.
2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.

H. Finish:
1. Indoor Units:
a. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
b. Color: Manufacturer's standard color.

2.04 FAN SECTION

A. Type: Air foil, single width, single inlet, centrifugal plug fan, in accordance with AMCA 99. See Section 23 3416

B. Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.

C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.

D. Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing.

E. Mounting:
1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
2. Factory mount motor on slide rails.
3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
4. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2-inches.

F. External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
1. All fan motors shall be factory-wired to individual manual motor protection [MMP] device which shall consist of a motor overload relay with adjustable current rating and an on-off disconnect switch for power isolation. Field wiring of MMP’s to fan motors shall not be permitted.
2. MMP’s shall be contained in a single control panel [MMP panel] and shall be mounted on the exterior wall panel of the fan array section.
3. MMP panel shall have a single point of connection for input power wiring and shall feed power individual MMP’s through a common busbar. Independent wiring of input power to individual MMP’s shall not be permitted.

G. Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted external motor junction box.

H. Fan Accessories:
1. See Section 23 3416

I. Flexible Duct Connections:
1. For separating fan, coil, and adjacent sections.

J. Drives:

1. Comply with AMCA 99.
2. Bearings: Heavy duty pillow block type, roller bearings with ABMA STD 11 L-10 life at 120,000 hours.
3. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

2.05 COIL SECTION

A. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.

B. Drain Pans: 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.

C. Eliminators: Three break of galvanized steel, mounted over drain pan.

D. Air Coils:
1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.

E. Fabrication:
1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
2. Fins: Aluminum.
3. Casing:
   a. Chilled Water Coils: Die formed channel frame of stainless steel.
   b. Hot Water Coils: Die formed channel frame of galvanized steel.

F. Water Heating Coils:
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.

G. Water Cooling Coils:
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.06 U-FRAME DEHUMIDIFER HEAT PIPES

A. General:
1. Air Handler(s) shall be equipped with Standard Tilted Enhanced Dehumidifier Heat Pipes supplied by Heat Pipe Technology, Inc. to precool the return/outside air and reheat the supply air in a wrap-around configuration. The Dehumidifier Heat Pipes shall be pre-fabricated in a U-Frame arrangement comprised of precool Heat Pipe and reheat Heat Pipe heat exchangers together in one assembly such that the assembly may be inserted into an air conditioning unit with the legs of the U-Frame unit on either side of the cooling coil of the air conditioning unit. The U-Frame assembly shall be configured such that the precool Heat Pipe shall be located immediately before the cooling coil and the reheat Heat Pipe shall be located immediately after the cooling coil. Heat Pipe circuits comprise multiple tubes connected in series, end-to-end to form a closed, continuous loop. Both vapor and liquid will travel in the same direction around the circuit in a single convectional path, making wicking and capillary action unnecessary for continuous heat transfer. The interconnecting piping between the Heat Pipe modules shall be located within the U-Frame unit. Any deviation from the specifications must be approved by the engineer no less than 10 days prior to the project bid date. No consideration of alternates will be given after that time. Heat pipes shall be completely manufactured and fully assembled at the manufacturer’s facility or on site by factory personnel. Conversion of third party coils is not acceptable.

B. Control Valves:
   1. The Dehumidifier Heat Pipe circuits shall be equipped with solenoid operated control valves to control the operation of the Heat Pipe circuits, four (4) stages of control each with an individual solenoid valve is required. The electrical power required by the solenoid valves shall be 24 VAC. The solenoid valves shall be wired to a terminal block within a NEMA enclosure located on the exterior surface of the equipment cabinet. All additional wiring, relays, transformers, and power supply etc. necessary to interface with the equipment control system, shall be provided and installed by others. Closing of a valve shall inactivate the Heat Pipe circuit in which it is installed. The valves shall be normally open. The control valves shall be grouped such that each group of valves shall control a designated fraction of the Heat Pipe circuits. With all control valves open, the Dehumidifier Heat Pipe assembly will operate at full capacity. If all the circuits are equipped with control valves, then closing all the valves will stop all Heat Pipe operation. Manufacturer shall provide at least three (3) references for successful controllable wraparound heat pipe installations for at least three (3) years.

C. Heat Pipes:
   1. The Heat Pipe supplier shall have a minimum of 5 years of experience designing and installing Heat Pipes specifically for dehumidification applications.
   2. The tubes shall be ½" OD copper, of specific design for Heat Pipe application, permanently expanded onto the fin collar to form a firm, rigid, and complete pressure contact at all operating conditions. Aluminum tubes will not be allowed.
   3. The fin surface shall be continuous plate type q aluminum q copper fins of specific design to produce maximum heat transfer efficiency for Heat Pipe applications. Airside pressure loss shall be as given on the schedule, or otherwise specified. Fin density and the number of rows of tubes shall be as specified.
   4. Heat transfer fluid shall be classified as Safety Group A1 in ASHRAE Standard 34-2013.
   5. Heat Pipe capacities, entering and leaving dry and wet bulb temperatures, and face velocity shall be as specified.
   6. The frame shall be minimum 16 gauge galvanized steel.
   7. Heat Pipe interconnecting piping and circuitry shall be as specified by Heat Pipe Technology design. Each circuit shall be individually processed, charged, hermetically sealed, and tested. Interconnecting piping shall be fully enclosed to provide complete protection.
   8. Scheduled effectiveness or heat recovery shall be met at a minimum and total pressure drop shall not be exceeded. The resulting Recovery Efficiency Ratio, or RER, shall therefore be met at a minimum.
   9. The Heat Pipes shall be ETL listed to UL standard 207 and CSA C22.2.140.3.
   10. The Heat Pipe heat exchanger shall have a five (5) year limited warranty. All components such as valves and dampers shall carry a 12-month warranty.

2.07 FILTER AND AIR CLEANER SECTION

A. General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.

B. Pleated Media Filters:
   1. Media: 2 inch, 100 percent synthetic fibers, continuously laminated to a grid with water repellent adhesive, and capable of operating up to a maximum of 625 fpm without loss of efficiency and holding capacity.
   2. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles..
   3. Minimum Efficiency Reporting Value: 8 MERV when tested in accordance with ASHRAE Std 52.2.

C. Differential Pressure Gauge:
   1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
   2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.08 DAMPER SECTION

A. Control Dampers: Low leakage (Class 1A) Control dampers. See Section 23 3300 - Air Duct Accessories.

B. Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor, return, and exhaust air.

C. Internal Face Damper Section: Provide as indicated within the air handling unit. Dampers shall be low leakage (Class 1A) Control dampers.

2.09 TOTAL ENERGY RECOVERY WHEEL SECTION

A. Manufacturers:
   1. Airxchange.
   2. American Energy Exchange, inc.
   3. Loren cook Company.
   4. SEMCO Incorporated.
   5. Greenheck.

B. Certified in accordance with AHRI 1060 (I-P) and UL 1812 for mechanical, electrical, and fire safety.

C. Wheel Construction: Polymer segmented wheel, (for wheels greater than 26-inch in diameter), strengthened with radial spokes.
   1. Enthalpy type for both sensible and latent heat recovery.
   2. Must insure laminar flow through at design conditions.
   3. Energy transfer ratings must be ARI Certified to Standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on ARI 1060.
   4. Desiccant shall be silica gel for maximum latent energy transfer, permanently bonded to wheel media, (sprayed on desiccant coatings or desiccant applied after wheel formation are not acceptable).
   5. Wheel shall transfer moisture entirely in the vapor phase.
   6. Polymer media shall be mounted in a stainless steel rotor.
   7. Maximum Solid Size for Media to Pass: 800 micrometer.

D. Motor:
   1. Thermally protected.
   2. Factory mounted.

E. Maintenance and Access Features:
   1. Access doors upstream and downstream of the wheel cassette.
   2. Removable wheel segments to facilitate maintenance and cleaning.
   3. Adequate space for cleaning, service, and maintenance.

2.10 ULTRAVIOLET LIGHTS

A. Manufacturers:
   1. Sanuvox Technologies Inc; Biowall: www.sanuvox.com/#sle.
   2. Steril-Aire, Inc; Rapid Install Kit: www.steril-aire.com/#sle.
   3. UV Resources; RLM Xtreme: www.uvresources.com/#sle.

B. Tested and recognized by UL 153, UL 1598, and UL 1995 for luminaries, heating, and cooling equipment.

C. UV-C Short Wave Light Array Performance: Provide not less than 190 microwatts/sq in.

D. Materials:
   1. Provide UV-C resistant polymeric materials or shield from direct or indirect UV-C light with UV-C tolerant material.
   2. UV-C Fixtures: Stainless steel to resist corrosion.

E. Lamp Life: 9000 hours minimum with no more than 20 percent loss of output after two years of continuous use.

F. Control Panel: Provide control panel for each UV-C light array.
   1. Comply with UL 508A.
   2. Use components marked with minimum SCCR (Short Circuit Current Rating).
   3. Provide enclosure with NEMA 4X rating for prevention of corrosion and water ingress.
   4. Provide control panel with current sensor to indicate status of UV-C array.

G. Safety Features:
   1. Treat view port and other windows to assure UV-C energy emitted is below threshold limit specified by American Conference of Governmental Industrial Hygienists (ACGIH).
   2. Provide mechanical interlock switch to disconnect power to UV-C fixtures when opening access door.
   3. Provide externally mounted, on-off, disconnect, and shutoff switch with lockout/tagout that disconnects UV-C power and prevents unwanted operation of UV-C lights.

2.11 ACCESS SECTION

A. Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.

B. Construct access doors same as previously specified within this Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Bolt sections together with gaskets.

C. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.

D. Provide fixed sheaves required for final air balance.

E. Make connections to coils with unions or flanges.

F. Hydronic Coils:
   1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
   2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
   3. Locate water supply at bottom of supply header and return water connection at top.
   4. Provide manual air vents at high points complete with stop valve.
   5. Ensure water coils are drainable and provide drain connection at low points.

G. Cooling Coils:
   1. Pipe drain and overflow to nearest floor drain.

3.02 SYSTEM STARTUP

A. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

B. UV-C system to be commissioned by manufacturer field representative.

3.03 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals for closeout submittals.

B. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Briefly describe function, operation, and maintenance of each component.

END OF SECTION

SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air-source heat pumps.

B. Air cooled condensing units.

C. Indoor air handling (fan and coil) units for ductless systems.

D. Controls.

1.02 RELATED REQUIREMENTS

A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.

B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units 2004.

C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units 2022.

D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2024.

F. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator.
   2. Heating: None.

3. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

C. Electrical Characteristics:
1. Refer to drawings for electrical load requirements.
2. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583.

2.02 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturer: System manufacturer.

2.03 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Comply with AHRI 210/240.
2. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
2. Provide heat pump reversing valves.

D. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.
2. Provide with dry-contacts for scheduling by BAS.

2.04 ACCESSORY EQUIPMENT

A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from setpoint.
3. Thermostat Display:
a. Actual room temperature.
b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

B. Condenser Wall Mounting Brackets:
1. Provide wall mounting brackets with neoprene vibration isolators and all required mounting hardware for units indicated to be wall mounted.

C. Condenser Dry Contacts:
1. Condensing units shall be provide with dry-contacts to allow scheduling of unit by BAS.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION

SECTION 26 0000
COMMON ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes common requirements for the entire project.

1.03 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, excavation, backfill, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Electrical System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Electrical Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised

of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.04 DEFINITIONS

A. Architect: The Architect of Record for the project, if any.

B. Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, shop drawings, field orders, change orders, cost breakdowns, construction manager's assignments, architect's supplemental instructions, periodical payment requests, etc.

1. Note: Any reference within these specifications to a specific entity, i.e. "Electrical Contractor" is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

C. Contractor: Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of mechanical work (Electrical, Low Voltage, Fire Alarm, etc.) or, the General Contractor.

D. Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

E. Furnish: Deliver to the site in good condition.

F. Install: Install equipment furnished by others in complete working order.

G. Provide: Furnish and install in complete working order.

1.05 INTENT

A. It is the intention of the Contract Documents to provide finished work, tested and ready for operation.

B. Minor details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work, the same as if herein specified or indicated.

1.06 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work. The Contract Drawings are not intended to show every vertical or horizontal offset which may be necessary to complete the systems. Contractor shall anticipate that additional offsets may be required without additional cost to the Owner and submit their bid accordingly.

B. The drawings and specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances,

unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, fixtures, outlets, switches, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Electrical equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Electrical drawings are intended to show the approximate locations of equipment, materials, conduit, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small and large scale drawings, the larger scale drawings shall take precedence.

I. The Electrical Contractor and his Sub-Contractors shall review all construction documents in detail as they may relate to his work (structural, architectural, site survey, mechanical, etc.). Review all drawings for general coordination of work, responsibilities, ceiling clearances, wall penetrations points, chase access, fixture elevations, etc. Make any pertinent coordination or apparent conflict comments to the Engineer at least ten days prior to bids, for issuance of clarification by written addendum.

J. The Electrical Contractor and his Sub-Contractors shall ensure there is adequate space to install the equipment and materials. Failure to do so shall result in the correction of such encroachment conflict or effect of any work awarded the proposer and shall be accomplished fully without additional expense to the Owner and that they are reasonably accessible for maintenance. Check closely all mechanical and electrical closets, chases, ceiling voids, wall voids, crawl spaces, etc., to ensure adequate spaces.

K. Where on the drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

L. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

M. Where on the Drawings or Addenda the word typical is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

N. Always check ceiling heights indicated on Architectural Documents and ensure they can be installed appropriately and that they may be maintained after all mechanical and electrical

equipment is installed. If a conflict is apparent, notify the Engineer in writing for instructions. Do not install equipment in the affected area until the conflict is resolved.

1.07 EQUIPMENT AND MATERIALS SUBSTITUTIONS OR DEVIATIONS

A. When any Contractor requests approval of materials and/or equipment of different physical size, weight, capacity, function, color, access, it shall be understood that such substitution, if approved, will be made without additional cost to anyone other than the Contractor requesting the change regardless of changes in connections, space requirements, electrical characteristics, etc.

B. In all cases where substitutions affect other trades, the Contractor requesting such substitutions shall advise all such Contractors of the change and shall compensate them for all necessary changes in their work. Any drawings, specifications, diagram, etc., required to describe and coordinate such substitutions or deviations shall be professionally prepared at the responsible Contractor's expense.

C. Review of shop drawings, submittals, etc. by the Engineer does not in any way absolve the Contractor of the responsibilities of equipment and materials substitutions or deviations.

D. Even with any reference in the specifications to any article, device, product, material, fixture, form, or type of construction by name, make or catalog number, such reference shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition; any devices, products, materials, fixtures, forms, or types of construction which, in the judgment of the Engineer, are equivalent to those specified are acceptable, provided the preceding provisions are met.

E. Wherever any equipment and material is specified exclusively only such items shall be used unless substitution is accepted in writing by the Engineer.

F. Each Contractor shall furnish along with the proposal a list of requested equipment and materials which is to be provided. Where several makes are mentioned in the specifications and the Contractor fails to state which they propose to furnish, the Engineer shall choose any of the makes mentioned without change in price. Inclusion in this list shall not ensure that the Engineers will approve shop drawings unless the equipment, materials, etc., submitted in shop drawings are satisfactorily comparable to the items specified and/or indicated.

G. Each Contractor shall give written notice to the Architect/Engineer 5 days prior to the submission of a proposal of any materials or apparatus believed inadequate or unsuitable; in violation of codes, laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, Proposers signify that they have included the cost of all required items in the proposal and that the Proposer will be responsible for the safe and satisfactory operation of the entire system without additional cost to the Owner.

1.08 COST BREAKDOWNS

A. Within thirty days after acceptance of the Contract, each Contractor is required to furnish to the Engineer one copy of a detailed cost breakdown on each respective area of work. These cost breakdowns shall be made on forms provided or approved by the Engineer or Architect. Payments will not be made until satisfactory cost breakdowns are submitted.

1.09 GUARANTEES AND WARRANTIES

A. Items of equipment which have longer guarantees, as called for in these specifications or as otherwise offered by the manufacturer, such as generators, engines, batteries, transformers, etc., shall have warranties and guarantees completed in order, and shall be in effect at the time of final acceptance of the work by the Engineer. The Contractor shall present the Engineer with such warranties and guarantees at the time of final acceptance of the work. The Owner reserves the right to use equipment installed by the Contractor prior to date of final acceptance. Such use of equipment shall in no way invalidate the guarantee except that Owner shall be liable for any damage to equipment during this period due to negligence of his operator or other employee.

1.10 RECORD DRAWINGS

A. The Contractor shall ensure that any deviations from the design are being recorded daily or as necessary on record drawings being maintained by the Contractor. Dimensions from fixed, visible permanent lines or landmarks shown in vertical and horizontal ways shall be utilized. Compliance shall be a requirement for final payment. Pay particular attention to the location of underfloor or underground exterior in-contract or utility-owned or leased service lines, main switches and other appurtenances important to the maintenance and safety of the Electrical System. Deliver these record drawings to the Engineer as a system is completed, within ten days of the mark-up and/or while the accuracy of the mark-ups can be verified visually. Monthly payment may be withheld if the requirement is not complied with.

1.11 EXAMINATION OF SITE AND CONDITIONS

A. Each Contractor shall be responsible for the conditions under which the work is to be performed, the site of the work, the structure of the ground, above and below grade, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work.

B. Each Contractor shall carefully examine all Drawings and Specifications and inform themselves of the kind and type of materials to be used throughout the project and which may, in any way, affect the execution of his work

C. Each Contractor shall fully acquaint himself with all existing conditions as to ingress and egress, distance of haul from supply points, routes for transportation of materials, facilities and services, availability of temporary or permanent utilities, etc. The Contractor shall include in his work all expenses or disbursements in connection with such matters and conditions. Each Contractor shall verify all work shown on the drawings and conditions at the site, and shall report in writing to the Engineer ten days prior to bid, any apparent omissions or discrepancies in order that clarifications may be issued by written addendum. No allowance is to be made for lack of knowledge concerning such conditions after bids are accepted.

1.12 SURVEYS, MEASUREMENTS AND GRADES

A. Contractor shall lay out his work and be responsible for all necessary lines, levels, elevations and measurements. He must verify the figures shown on the drawings before laying out the work and will be held responsible for any error resulting from his failure to do so.

B. Contractor shall base all measurements, both horizontal and vertical from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.

C. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, he shall notify the Engineer thru normal channels of job communication and shall not proceed with his work until he has received instructions from the Engineer.

1.13 QUALIFICATIONS OF WORKMEN

A. The installation of all Electrical Work shall be performed by licensed electricians and in accordance with current State Law. All Electrical Contractors bidding this project must have been a licensed company for a minimum of three years to qualify to bid this project. Individual employee experience does not supersede this requirement.

B. All subcontractors bidding the electrical work must have completed one project of 70% this subcontract cost size and two projects of 50% this subcontract cost size.

C. All electrical work shall be accomplished by qualified workmen competent in the area of work for which they are responsible. Untrained and incompetent workmen as evidenced by their workmanship shall be relieved of their responsibilities in those areas. The Engineer shall reserve the right to determine the quality of workmanship of any workman and unqualified or incompetent workmen shall refrain from work in areas not satisfactory to him. Requests for relief of a workman shall be made through the normal channels of responsibility established by the Architect or the contract document provisions.

D. All electrical work shall be accomplished by Journeymen electricians under the direct supervision of a licensed Electrician. All applicable codes, utility company regulations, laws and permitting authority of the locality shall be fully complied with by the Contractor.

E. Special electrical systems, such as Fire Detection and Alarm Systems, Intercom or Sound Reinforcement Systems, Telecommunications or Data Systems, Lightning Protection Systems, Video Systems, Special Electronic Systems, Control Systems, etc., shall be installed by workmen normally engaged or employed in these respective trades. As an exception to this, where small amounts of such work are required and are, in the opinion of the Engineer, within the competency of workmen directly employed by the Contractor involved, they may be provided by this Contractor.

1.14 CONDUCT OF WORKMEN

A. The Contractor shall be responsible for the conduct of all workmen under his supervision. Misconduct on the part of any workmen to the extent of creating a safety hazard, or endangering the lives and property of others, shall result in the prompt permanent dismissal of that workman from the project. The possession, consumption or influence of alcoholic beverages, narcotics or illegally used controlled substances on the jobsite is strictly forbidden. Possession of a fire-arm is prohibited and may result in prosecution. Foul or bad language, graffiti is strictly prohibited. Display of nude tattoos is prohibited.

1.15 SUPERVISION OF WORK

A. The Contractor shall personally supervise the work for which they are responsible or have a competent superintendent, approved by the Engineers, on the work at all times during progress with full authority to act on behalf of the Contractor.

1.16 MATERIALS AND WORKMANSHIP

A. All electrical equipment, materials and articles incorporated in the work shall be new and of comparable quality to that specified. All workmanship shall be first-class and shall be performed by electricians skilled and regularly employed in their respective trades. The Contractor shall determine that the equipment he proposes to furnish can be brought into the building(s) and installed within the space available. All equipment shall be installed so that all parts are readily accessible for inspection, maintenance, replacement, etc. Extra compensation will not be allowed for relocation of equipment for accessibility or for dismantling equipment to obtain entrance into the building(s).

B. All conduit and/or conductors shall be concealed underground, within crawl space in or below walls, floors or above ceilings unless otherwise noted. All fixtures, devices and wiring required shall be installed to make up complete systems as indicated on the drawings and specified herein. Raceways shall not be placed within foundation walls and footings. See notes on plans about the limitation on work allowed to be installed within the crawl space.

C. All materials, where applicable, shall bear Underwriters' Laboratories label or that of another Engineer-approved testing agency, where such a standard has been established.

D. Each length of conduit, wireway, duct, conductor, cable, fitting, fixture and device used in the electrical systems shall be stamped or indelibly marked with the maker’s mark or name.

E. All electrical equipment shall bear the manufacturer's name and address and shall indicate its electrical capacity and characteristics.

F. All electrical materials, equipment and appliances shall conform to the latest standards of the National Electric Manufacturers Association (NEMA) and the National Board of Fire Underwriters (NBFU) and shall be approved by the Owner's insuring agency if so required.

1.17 COOPERATION AND COORDINATION WITH OTHER TRADES

A. The Contractor is expressly directed to read the General Conditions and all sections of these specifications for all other trades and to study all drawings applicable to his work, including Architectural, Plumbing, Fire Protection, Mechanical and Structural drawings, to the end that complete coordination between trades will be affected. Each Contractor shall make known to all other contractors the intended positioning of materials, raceways, supports, equipment and the

intended order of his work. Coordinate all work with other trades and proceed with the installation in a manner that will not create delays for other trades or affect the Owner's operations.

B. Special attention to coordination shall be given to points where raceways, fixtures, etc., must cross other ducts or conduit, where lighting fixtures must be recessed in ceilings, and where fixtures, conduit and devices must recess into walls, soffits, columns, etc. It shall be the responsibility of each Contractor to leave the necessary room for other trades. No extra compensation or time will be allowed to cover the cost of removing fixtures, devices, conduit, ducts, etc. or equipment found encroaching on space required by others.

C. The Contractor shall be responsible for coordination with all trades to ensure they have made provisions for connections, operational switches, disconnect switches, fused disconnects, etc., for electrically operated equipment provided under this or any other division of the specifications, or as called for on the drawings. Any connection, circuiting, disconnects, fuses, etc., that are required for equipment operation shall be provided as a part of this contract.

D. If any discrepancies occur between accompanying drawings and these specifications and drawings and specifications covering other trade's work, each trade shall report such discrepancies to the Engineer far enough in advance so that a workable solution can be presented. No extra payment will be allowed for relocation of fixtures, devices, conduit, and equipment not installed or connected in accordance with the above instructions.

E. In all areas where air diffusers, devices, luminaires and other ceiling-mounted devices are to be installed, the Mechanical Trade(s) and the Electrical Trade and the General Trades shall coordinate their respective construction and installations so as to provide a combined symmetrical arrangement that is acceptable to the Engineer. Where applicable, refer to reflected ceiling plans. Request layouts from the Engineer where in doubt about the potential acceptability of an installation.

1.18 INTERFACING

A. Each Electrical Trade, Specialty Controls Trade, Mechanical Trade and the General Trades, etc., shall ensure that coordination is effected relative to interfacing of all systems. Some typical interface points are (but not necessarily all):

1. Connection of Telecommunications (voice, video, data) lines to Owner's existing or new services.
2. Connection of Power lines to Owner's existing or new services.
3. Connection of all controls to equipment.
4. Electrical power connections to electrically operated (or controlled) equipment.
5. Electrical provisions for all equipment provided by other trades or suppliers within this contract.

1.19 CONNECTION TO EQUIPMENT FURNISHED BY OTHERS

A. Each Contractor shall make all connections to equipment furnished by others, whenever such equipment is shown on any part of the drawings or mentioned in any part of the Specifications, unless otherwise specifically specified hereinafter.

B. All drawings are complementary, one trade of the other. It is the Contractor's responsibility to examine all drawings and specifications to determine the full scope of his work. The project Engineers have arranged the specifications and drawings in their given order solely as a convenience in organizing the project, and in no way shall they imply the assignment of work to specific trades, contractors, subcontractors or suppliers.

C. Supervision to assure proper installation, functioning and operation shall be provided by the Contractor furnishing the equipment or apparatus to be connected.

D. Items indicated on the drawings as rough-in only (RIO) will be connected by the equipment supplier or Owner, as indicated. The Contractor shall be responsible for rough-in provisions

only as indicated. These rough-ins shall be in accord with the manufacturer's or supplier's requirements.

E. For items furnished by others, relocated, or RIO, the Contractor shall obtain from the supplier or shall field determine as appropriate, the exact rough-in locations and connection sizes for the referenced equipment.

F. The Contractor shall be responsible for coordinating with the General and all other trades, as necessary, to determine any and all final connections that he is to make to equipment furnished by others.

1.20 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATIONS, ETC.

A. The Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. The Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. The Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, or municipalities and with the requirements of all governmental agencies having jurisdiction.

F. All materials and equipment shall bear the approval label of, or shall be listed by the Underwriters' Laboratories (UL), Incorporated. Each packaged assembly shall be approved as a package. Approval of components of a package shall not be acceptable.

G. Where minimum code requirements are exceeded in the Design, the Design shall govern.

H. The Contractor shall ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

I. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

J. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

1.21 TEMPORARY SERVICES

A. The Contractor shall arrange with the General Contractor or Construction Manager for temporary electrical and other services which he may require to accomplish his work. In the absence of other provisions in the contract, the Contractor shall provide for his own temporary services of all types, including the cost of connections, utility company fees, construction, removal, etc., in his bid.

B. All temporary services shall be removed by Contractor prior to acceptance of work.

1.22 TEMPORARY USE OF EQUIPMENT

A. The permanent electrical equipment, when installed, may be used for temporary services, subject to an agreement between the Contractors involved, the Owner, and with the consent of the Engineer. Should the permanent systems be used for this purpose, each Contractor shall pay for all temporary connections required and any replacements required due to damage without cost, leaving the equipment and installation in "as new" condition.

B. Permission to use the permanent equipment does not relieve the Contractors who utilize this equipment from the responsibility for any damages to the building construction and/or equipment which might result because of its use.

1.23 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be entirely responsible for all material and equipment furnished in connection with the work and special care shall be taken to properly protect all parts thereof from damage during the construction period. Such protection shall be by a means acceptable to the Engineer. All rough-in conduit shall be properly plugged or capped during construction in a manner approved by the Engineer.

B. Equipment damaged, stolen or vandalized while stored on site, either before or after installation, shall be repaired or replaced (as determined by the Engineer) by the responsible Contractor. Electrical equipment exposed to the weather shall be replaced by the Contractor at the Contractor’s expense.

1.24 EQUIPMENT SUPPORT

A. Each piece of equipment, apparatus, or conduit suspended from the ceiling or mounted above the floor level shall be provided with suitable structural support, conduit rack, or platform in accordance with the best recognized practice. Such supporting or mounting means shall be provided by the Contractor for all equipment and conduit. Exercise extreme care that structural members of building are not overloaded by such equipment. Provide any required additional bracing, cross members, angles, support, etc.

1.25 REQUIRED CLEARANCE FOR ELECTRICAL EQUIPMENT

A. The NEC has specific required clearances above, in front, and around electrical gear, panels etc.

B. Contractor shall ensure that no piping, ductwork, etc., is installed in the required clearance. If any appurtenance is located in the NEC required clearance, it shall be relocated without additional cost to the Owner.

1.26 ACCESSIBILITY

A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate clearance in partitions and above suspended ceilings for the proper installation of his work. He shall cooperate with the General Contractor (or Construction Manager) and all other Contractors whose work is in the same space, and shall advise each Contractor of his requirements. Such spaces and clearances shall be kept to the minimum size required to ensure adequate clearance and access.

B. The Contractor shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include but not be limited to junction boxes, pull boxes, contactors, panels, disconnects, controllers, switchgear, etc. Minor deviations from drawings may be made to allow for better accessibility, and any change shall be approved where the equipment is concealed.

C. Each Contractor shall provide (or arrange for the provision by other trades) the access panels for each concealed junction box, pull box, fixtures or electrical device requiring access or service as shown on Engineer's plans or as required. Locations of these panels shall be identified in sufficient time to be installed in the normal course of work. All access panels shall be installed in accord with the Architect's standards for such work.

D. Access Doors; in Ceilings or Walls:

1. In mechanical, electrical, or service spaces:
   a. 14-gauge aluminum, 1" border, refer to architectural specifications for finishes
2. In finished areas:
   a. 14-gauge primed steel with 1" border to accept the architectural finishes specified for the space. Confirm these provisions with the Architect prior to obtaining materials or installing any such work.
3. In fire or smoke rated partitions, access doors shall be provided that equal or exceed the required rating of the construction they are mounted in.
4. All access doors shall have continuous hinge and screw type cover. Openings shall be sized to allow personal to pass through.

E. Sides of cable trays cannot be obstructed by pipes, ductwork, cables, etc.

1.27 MAINTENANCE OF EXISTING UTILITIES AND LINES

A. The locations of all piping, conduits, cables, utilities and manholes existing, or otherwise, that come within the contract construction site, shall be subject to continuous uninterrupted maintenance with no exception unless the Owner of the utilities grants permission to interrupt same temporarily, if need be. Provide one week's written notice to Engineer, Architect and Owner prior to interrupting any utility service or line. Also, see Article 1. - General, this section.

B. Known utilities and lines as available to the Engineer are shown on the drawings. However, it is additionally required that, prior to any excavation being performed, each Contractor ascertain and mark all utilities or lines that would be endangered by the excavation. Contractor shall bear costs of repairing damaged utilities.

C. If the above-mentioned utilities or lines occur in the earth within the construction site, the Contractor shall first probe and make every effort to locate the lines prior to excavating in the respective area.

D. Cutting into existing utilities and services shall be done in coordination with and as designated by the Owner of the utility. The Contractor shall work continuously to restore service(s) upon deliberate or accidental interruption, providing premium time and materials as needed without extra claim to the Owner.

E. The Contractor shall repair to the satisfaction of the Engineer any surface or subsurface improvements damaged during the course of the work, unless such improvement is shown to be abandoned or removed.

F. Machine excavation shall not be permitted within ten feet of existing gas or fuel lines. Hand excavate only in these areas, in accord with utility company, agency or other applicable laws, standards or regulations.

G. Protect all new or existing lines from damage by traffic, etc. during construction.

H. Protect existing trees, indicated to remain with fencing or other approved method. Hold all new subsurface lines outside the drip line of trees, offsetting as necessary to protect root structures. Refer to planting or landscaping plans, or in their absence, consult with the Architect.

1.28 RESTORATION OF NEW OR EXISTING SHRUBS, PAVING, ETC.

A. The Contractor shall replace to their original condition all paving, curbing surfaces, drainage ditches, structures, fences, shrubs, existing or new building surfaces and appurtenances, and any other items damaged or removed by his operations. Replacement and repairs shall be in accordance with good construction practice and shall match materials employed in the original construction of the item to be replaced. All repairs shall be to the satisfaction of the Engineer, and in accord with the Architect's standards for such work, as applicable. Patchwork on new construction will not be accepted.

1.29 CONCRETE WORK

A. The Contractor shall be responsible for the provision of all concrete work required for the installation of any of his systems or equipment. If this work is provided by another trade, it will

not relieve the Electrical Contractor of his responsibilities relative to dimensions, quality of workmanship, locations, etc. In the absence of other concrete specifications, all concrete related to Electrical work shall be 3000 PSI minimum compression strength at 28 days curing and shall conform to the standards of the American Concrete Institute Publication ACI-318. Heavy equipment shall not be set on pads for at least seven days after pour.

B. All concrete pads shall be complete with all pipe sleeves, embeds, anchor bolts, reinforcing steel, concrete, etc., as required. Pads larger than l8" in width shall be reinforced with minimum #4 round bars on 6" centers both ways. All reinforcing steel shall be per ASTM requirements, tied properly, lapped 18 bar diameters and supported appropriately up off form, slab or underlayment. Bars shall be approximately 3" above the bottom of the pad with a minimum 2" cover. All parts of pads and foundations shall be properly rodded or vibrated. If exposed parts of the pads and foundations are rough or show honeycomb after removing forms properly adhered repairs shall be made. If structural integrity is violated, the concrete shall be replaced. All surfaces shall be rubbed to a smooth finish and chamfered edges.

C. All pads and concrete lighting standard bases shall be crowned slightly in center to avoid water ponding beneath equipment.

D. In general, concrete pads for small equipment shall extend 6" beyond the equipment's base dimensions. For large equipment with service access panels, extend pads l8" beyond base or overall dimensions to allow walking and servicing space at locations requiring service access.

E. Exterior concrete pads shall be 4" minimum above grade and 4" below grade on a tamped 4" dense grade rock base unless otherwise noted or required by utility company. Surfaces of all foundations and bases shall have a smooth finish with three-quarter inch radius or chamfer on exposed edges, troweled or rubbed smooth. All exterior pads shall be crowned approximately 1/8" per foot, sloping from center for drainage.

1.30 FINAL CONNECTIONS TO EQUIPMENT

A. The roughing-in and final connections to all electrically operated equipment furnished under this and all other sections of the contract documents or by others, shall be included in the Contract and shall consist of furnishing all labor and materials for connection and proper testing. The Contractor shall carefully coordinate with equipment suppliers, manufacturer’s representatives, the vendor or other trades to provide complete electrical and dimensional interface to all such equipment (kitchen, hoods, mechanical equipment, panels, refrigeration equipment, etc.).

1.31 ELECTRICAL CONNECTIONS

A. The Contractor shall furnish and install all power wiring and fusing complete from power source to motor or equipment junction box, including power wiring through starters. The Contractor shall install all starters not factory mounted on equipment. Unless otherwise noted, the supplier of equipment shall furnish starters with the equipment. Also, refer to Division 25 of Specifications, shop drawings and equipment schedules for additional information.

B. All control, interlock, sensor, thermocouple and other wiring required for equipment operation shall be provided by the Contractor. All such installations shall be fully compliant with all requirements of Division 26 regardless of which trade actually installs such wiring. Motors and equipment shall be provided for current and voltage characteristics as indicated or required. All wiring shall be enclosed in raceways unless otherwise noted.

C. Each Contractor or sub-contractor, prior to bidding the work, shall coordinate power, control, sensor, interlock and all other wiring requirements for equipment or motors with all other contractors or sub-contractors, to ensure all needed wiring is provided in the Contract. Failure to make such coordination shall not be justification for claims of extra cost or a time extension to the Contract.

1.32 MOTORS

A. Each motor shall be provided by the equipment supplier or manufacturer with conduit terminal box, adequate starting and internal thermal overload protective equipment as specified or required. The capacity shall be sufficient to operate associated driven devices under all conditions of operation and load and without overload, and at least of the horsepower indicated

or specified. Each motor shall be selected for quiet operation, maximum efficiency and lowest starting KVA per horsepower as applicable. Also, see mechanical specification for further requirements and scheduled sizes.

1.33 QUIET OPERATION, SUPPORTS, VIBRATION AND OSCILLATION

A. All work shall operate under all conditions of load without any objectionable sound or vibration, the performance of which shall be determined by the Engineer. Noise from moving machinery or vibration noticeable outside of room in which it is installed, or annoyingly noticeable noise or vibration inside such room, will be considered objectionable. Sound or vibration conditions considered objectionable by the Engineer shall be corrected in an approved manner by the Contractor (or Contractors responsible) at his expense.

B. All equipment subject to vibration and/or oscillation shall be mounted on vibration supports suitable for the purpose of minimizing noise and vibration transmission, and shall be isolated from external connections such as piping, ducts, etc., by means of flexible connectors, vibration absorbers or other approved means. Surface mounted equipment such as panels, switches, etc., shall be affixed tightly to their mounting surface.

C. The Contractor shall provide supports for all equipment furnished by him using an approved vibration isolating type as needed. Supports shall be liberally sized and adequate to carry the load of the equipment and the loads of attached equipment, piping, etc. All equipment shall be securely fastened to the structure either directly or indirectly through supporting members by means of bolts or equally effective means. No work shall depend on the supports or work of unrelated trades unless specifically authorized in writing by the Architect or Engineer.

1.34 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide his own cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Electrical Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. He shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Electrical Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Each Electrical Contractor shall cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Each Electrical Contractor shall notify other trades in due time where he will require openings of chases in new concrete or masonry. He shall set all concrete inserts and sleeves for his work. Failing to do this, he shall cut openings for his work and patch same as required at his own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Electrical Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing

or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Electrical trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

1.35 SLEEVES AND PLATES

A. Each Contractor shall provide and locate all sleeves and inserts required for his work before the floors and walls are built, or shall be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all electrical conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall (none are permitted thru roof) or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

1.36 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. The Contractor

shall furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

1.37 SMOKE AND FIRE PROOFING

A. The Contractor shall not penetrate rated fire walls, ceilings or floors with conduit, cable, bus duct, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the rating of the assembly. Smoke and fire stop all openings made in walls, chases, ceiling and floors. Patch all openings around conduit, wireway, bus duct, etc., with appropriate type material to smoke stop walls and provide needed fire rating at fire walls, ceilings and floors. Smoke and fire proofing materials and method of application shall be approved by the local authority having jurisdiction. Submit means to be used.

1.38 WELDING

A. The Contractor shall be responsible for quality of welding done by his organization and shall repair or replace any work not done in accordance with the Architect's or structural Engineer's specifications for such work. If required by the Engineer, the responsible Contractor shall cut at least three welds during the job for X-raying and testing. These welds are to be selected at random and shall be tested as a part of the responsible Contractor's work. Certification of these tests and X-rays shall be submitted, in triplicate, to the Engineer. In case a faulty weld is discovered, the Contractor shall be required to furnish additional tests and corrective measures until satisfactory results are obtained. All welding to be accomplished by certified welder.

1.39 SCAFFOLDING, RIGGING AND HOISTING

A. Each Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

1.40 INSPECTION, APPROVALS AND TESTS

A. Before requesting a final review of the installation from the Architect and/or Engineer, each Contractor shall thoroughly inspect his installation to assure that the work is complete in every detail and that all requirements of the Contract Documents have been fulfilled. Failure to accomplish this may result in charges from the Architect and/or Engineers for unnecessary and undue work on their part.

B. Owner's and Engineer's inspections: Two inspections will be held to generate and then review punchlist items. All site visits thereafter shall be billed to the Contractor at the Engineer's standard hourly rates.

C. The Contractor shall provide as a part of this contract electrical inspection an inspector, licensed to provide such services. All costs incidental to the provision of electrical inspections shall be borne by the Contractor.

D. The Contractor shall advise each Inspection Agency in writing (with an information copy of the correspondence to the Architect and/or Engineer) when he anticipates commencing work. Failure of the Inspection Agency to inspect the work in the stage following and submit the related reports may result in the Contractor's having to expose concealed work not so inspected. Such exposure will be at the expense of the responsible Contractor.

E. Inspections shall be scheduled for rough-in as well as finished work. The rough-in inspections shall be divided into as many inspections as may be necessary to cover all roughing-in without fail. Report of each such inspection visit shall be submitted to the Architect, Engineer and the Contractor within three days of the inspection.

F. Approval by an Inspector does not relieve the Contractor from the responsibilities of furnishing equipment having a quality of performance equivalent to the requirements set forth in these plans and specifications. All work under this contract is subject to the review of the Architect and/or Engineer, whose decision is binding.

G. Before final acceptance, the Contractor shall furnish the original and three copies of the certificates of final approval by the Electrical Inspector (as well as all other inspection certificates) to the Engineer with one copy of each to the appropriate government agencies, as applicable. Final payment for the work shall be contingent upon completion of this requirement.

H. The Contractor shall test all wiring and connections for continuity and grounds before equipment and fixtures are connected, and when indicated or required, demonstrate by Megger Test the insulation resistance of any circuit or group of circuits. Where such tests indicate the possibility of faulty insulation, locate the point of such fault, pull out the defective conductor, replacing same with new and demonstrate by further test the elimination of such defect.

1.41 OPERATING INSTRUCTIONS

A. Upon completion of all work and all tests, each Contractor shall furnish the necessary skilled labor and helpers for operating his systems and equipment for a period of three days of eight hours each, or as otherwise specified. During this period, instruct the Owner or his representative fully in the operations, adjustment, and maintenance of all equipment furnished. Give at least one week's written notice to the Owner, Architect and Engineer in advance of this period. Contractor shall prepare an agenda for approval by Owner. The Engineer may attend any such training sessions or operational demonstrations. The Contractor shall certify in writing to the Engineer with copy to the Owner and Architect that such demonstrations have taken place, noting the date, time and names of the Owner's representative that were present.

B. Each Contractor shall furnish three complete bound sets for approval to the Engineer of typewritten and/or blueprinted instructions for operating and maintaining all systems and equipment included in this contract. All instructions shall be submitted in draft, for approval, prior to final issue. Manufacturer's advertising literature or catalogs will not be acceptable for operating and maintenance instructions. Each section shall be properly tabbed, indexed and labeled, with a table of contents. Minimum 3-ring hard cover binder. Include specific part, catalog, model, serial, and shop order numbers; statement of warranties – indexed by section; manufacturer names, P.O.C. for warranties, etc.

C. Each Contractor, in the above-mentioned instructions, shall include the maintenance schedule for the principal items of equipment furnished under this contract and a detailed, easy to read parts list and the name and address of the nearest source of supply.

1.42 CLEANING

A. Contractor shall, at all times, keep the area of their work presentable to the public and clean of rubbish and debris caused by operations; and at the completion of the work, shall remove all rubbish, debris, all of his tools, equipment, temporary work and surplus materials from and about the premises, and shall leave the area clean and ready for use.

B. If the Contractor does not attend to cleaning upon request, the Engineer may cause cleaning to be done by others and charge the cost of same to the Contractor.

C. Contractor shall be responsible for all damage from fire which originates in, or is propagated by, accumulations of the Contractor’s rubbish or debris.

D. After completion of all work and before final acceptance of the work, the Contractor shall thoroughly clean all equipment and materials and shall remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

1.43 PAINTING

A. Each fixture, device, panel, junction box, etc., that is located in a finished area shall be provided with finish of color and type as selected or approved by the Architect or Engineer. If custom color is required by the plans or specifications, it shall be provided at no additional cost to the Owner. All other equipment, fixtures or devices located in finished or unfinished areas, that are not required to have or are provided with finish color or coating shall be provided in a prime painted condition, ready to receive finish paint or coating. All galvanized metal in finished areas and exposed on exterior shall be properly prepared with special processes to receive finish paint as directed and approved by the Architect.

1.44 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

1.45 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0000

SECTION 26 0502
DESCRIPTION OF ELECTRICAL SYSTEM

PART 1 - GENERAL

1.01 PRIMARY ELECTRICAL SERVICE

A. Primary electrical service is new, overhead and underground, nominal 15,000 volts, three-phase, wye, to pad-mounted transformers as indicated on the plans.

B. In general, the utility company provides the pad-mounted transformers, primary cable and its terminations. Conduits routed off the property and connected to or near a manhole or pole and all other work shall be in accord with utility company requirements. Contact the utility company prior to bidding the work and include any and all charges for their work in bid.

1.02 SECONDARY ELECTRICAL SERVICE

A. Secondary service shall be 277/480V/3Ø/4W with solid grounded neutral. See Electrical Riser Diagram. Trench, backfill, conduit duct bank, conductors, and lugs are by Electrical Contractor, all per utility company standards. Metering is at pad-mounted transformers.

1.03 ADDITIONAL UTILITY COMPANY REQUIREMENTS

A. Contact the utility company for specifics on construction of pads, conduit, etc., prior to bidding the work and determine all their requirements. All work shall be in accord with their standards.

1. Utility Company: CenterPoint Energy
2. Major Underground Contact:
    a. Tanvi Jaggi at (713) 207-6242 and Tanvi.jaggi@centerpointenergy.com
3. Overhead Contact:
    a. Shalonda Smith at (832) 773-6045 and Shalonda.smith@centerpointenergy.com

B. Contractor is responsible for all fees, permit costs, etc., from the electrical utility company and the telephone company. This includes any cost associated with the underground electrical service extension.

C. Each Contractor, prior to bidding the work, is to contact the electrical utility company (as well as the telephone and cable T.V. utility company) and determine the exact points of extension of all underground services in the field with a representative of each utility company. Also, obtain construction details on manholes, transformer pads, pedestal stub-ups, etc., from each utility company as applicable. Extension points indicated on the plans are approximate, and are given for the bidder's information only.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0502

SECTION 26 0503
ELECTRICAL SHOP DRAWINGS AND SUBMITTALS

PART 1 - GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced so the specifications, schedules, light fixture numbers, panel names and numbers, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:

1. Power Equipment:
    a. Switchboards and panelboards.
    b. Transformers.
    c. Generators.
    d. Automatic transfer switches.
    e. Circuit breakers or fusible switches, per each type.
    f. Power and lighting contactors.
    g. Disconnect switches.
    h. Fuses, per each type required.

i. Magnetic starters, if not submitted with unit equipment by supplier.

j. Control components (relays, timers, selector switches, pilots, etc.)

k. Building service grounding electrode components.

2. Raceways:

a. Conduit (each type).

b. Wireways and each type of wireway fitting.

c. Surface raceways and fittings.

d. J-hook assembly.

e. Junction, pull, and device boxes

3. Devices:

a. Building wire, cable splices, and terminations

b. Each type of wiring device and their coverplates.

c. Any special items not listed above.

4. Lighting:

a. Light fixtures, each by type, marked to indicate all required accessories and lamp selection. Also, provide original color selection chart to allow Architect and/or Engineer to indicate color selection.

b. Lighting standards or poles.

c. Sports lighting system.

d. Photocells, time clocks, contactors or other lighting accessories.

e. Control systems (lighting).

5. Miscellaneous

a. Control panel assemblies.

b. Non-standard junction/pullboxes

G. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:

1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.

a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.

c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.

d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches

shall include necessary keys, handles and operators for valves, switches, breakers, etc. and keys to electrical panels, alarm pull boxes and panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Upon Substantial Completion of the Project, the Electrical Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) complete, tabbed, electronic copies of emergency, operation and maintenance instructions and parts lists for all equipment provided. These documents shall at least include:

1. Detailed operating instructions.
2. Detailed maintenance instructions including preventive maintenance schedules.
3. Addresses and phone numbers indicating where parts may be purchased.
4. Reference architectural specifications for additional requirements.

B. Refer to individual Contract Document Specification Sections for additional requirements.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0503

SECTION 26 0510
SCOPE OF THE ELECTRICAL WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Each Electrical Contractor's attention is directed to Division 26 Section “Common Electrical Requirements” and all other Contract Documents as they apply to his work.

1.02 SCOPE

A. The Electrical work for this project includes all labor, materials, equipment, fixtures, excavation, backfill and related items required to completely install, test, place in service and deliver to the Owner complete electrical systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:

1. All conduits, conductors, outlet boxes, fittings, etc.
2. All j-hooks, supports, outlet boxes, fittings, etc. for Division 27 and 28.
3. All switchgear, panels, disconnect switches, fuses, transformers, contactors, etc.
4. All generators and automatic transfer switches.
5. All wiring devices and device plates.
6. All light fixtures, poles and lamps.

B. Electrical connection to all electrically operated equipment furnished and/or installed by others, including sports lighting equipment, HVAC equipment, plumbing equipment, foodservice equipment, AV equipment, technology equipment, etc.

C. Inspection of electrical system by an approved Electrical Inspector, in compliance with local requirements.

D. Grounding, both building and telecommunications, per NEC and the specified requirements.

E. All necessary coordination with electric utility company, telephone company, cable T.V. Co., etc., to ensure that work, connections, etc., that they are to provide is accomplished.

F. All necessary fees and cost for permits, inspections, etc. Provision of electrical power, telephone and cable television services into the building from the utility termination points outside.

G. Rough-in for data/voice network as indicated.

H. Rough-in for paging-intercom system as indicated.

I. Rough-in for integrated audio-video systems as indicated.

J. Rough-in for local sound systems as indicated.

K. Rough-in for video surveillance system as indicated.

L. Rough-in for intrusion detection system as indicated.

M. Rough-in for access control system as indicated.

N. Rough-in for emergency responder radio antenna system as indicated.

O. Rough-in for fire alarm system.

P. Special Note: A specialty sub-contractor (Electronic Systems Contractor) shall be utilized for all paging-intercom system, data/voice network, fire alarm work, sound systems, intrusion detection system and for the security access control system installation. The sub-contractor shall be especially skilled in such work and shall be able to demonstrate that their regular business involves such installations. The specialty sub-contractor(s) shall be acceptable to and approved by the Owner. The names of each such sub-contractor shall be listed on the form of proposal at the time of opening bids. Provisions for branch circuits, pulling of cabling, and installation of raceways for specialty systems may be regular sub-contractor if approved by

specialty contractor. All terminations, connections, check-out and testing shall be by specialty contractor.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 26 0510

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Variable frequency drive cable, rated 600 V and less.
3. Metal-clad cable, Type MC, rated 600 V and less.
4. Connectors, splices, and terminations rated 600 V and less.
5. Sleeves and sleeve seals for cables.

1.02 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. VFD: Variable frequency drive.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of product indicated. Provide data for conductors and cables including, but not be limited to, the following:

1. Complete physical properties of the conductors and cables.
2. Ampacity for use intended.
3. Allowable stresses and requirements for installations, including bend radii, linear stress, and other pertinent data.
4. Types of connectors for terminations.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For conductors and cables, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Manufacturer's routine maintenance requirements for cables, terminations and all installed components.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.07 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V and less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Alcan Products Corporation; Alcan Cable Division.
   2. Alpha Wire.
   3. Belden Inc.
   4. Encore Wire Corporation.
   5. General Cable Corporation.
   6. Southwire Company.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Copper Conductors: Comply with NEMA WC 70. All conductors shall be 98% conductive annealed copper unless noted otherwise. Comply with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Aluminum Conductors: Comply with NEMA WC 70. Comply with ASTM B 800 and ASTM B 801.

F. Aluminum Conductors: XHHW-2
   1. AA-8000 series electrical grade aluminum alloy conductor material in compliance with NFPA 70, Chapter 3.
   2. Compact stranded conductors.

G. Conductor Insulation:
   1. Type THHN and Type THWN-2: Comply with UL 83.
   2. Types THW and Type THW-2: Comply with NEMA WC-0/ICEA S-95-658 and UL 83.
   3. Type XHHW-2: Comply with UL 44.

2.02 VARIABLE FREQUENCY DRIVE (VFD) CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AmerCable.
   2. General Cable Corporation.

B. Standards:
   1. Comply with UL 1277 Type TC-ER per NEC Article 336.
   2. Comply with UL 1685 vertical tray flame test.
   3. Comply with IEEE 1202 vertical tray flame test at 70,000 BTU/hour.
   4. Comply with CSA FT4.
   5. Comply with Oil & Sunlight resistant.
   6. RoHS compliant and CE approved.

C. Cable (minimum requirements):
   1. 600V/1000V rated, high stranded tinned copper conductors, shielded engineered for use with Variable Frequency Drives.
   2. Insulation shall be rated for 90 deg C wet/dry operating temperature.
   3. Suitable for Class I and II; Division 2 hazardous locations.

D. Conductor Material:
   1. Stranded tinned copper: Annealed fine wire flexible high strand count.
   2. Three (3) phase conductors, three (3) ground conductors. Each of the three ground conductors shall be the same size as the single ground conductor shown on the Drawings.

E. Insulation:
   1. Flame-Retardant Cross-Lined Polyolefin.
   2. Conductors shall be cabled together. Ground conductors shall be symmetrical. Fillers shall be included as necessary to make the cable round.

F. Shielding: Overall tinned copper braid plus aluminum/polyester tape foil, 100% coverage.

G. Jacket: Flame-retardant Thermoplastic, suitable for 90 deg C use.

H. Termination Kit: Pre-sized and pre-formed specifically for VFD cable constructions. Obtain from VFD cable manufacturer.

2.03 MULTICONDUCTOR CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Belden Inc.
   2. Encore Wire Corporation.
   3. General Cable Corporation.
   4. Southwire Company.

B. Metal-Clad Cable, Type MC: A factory assembly of insulated current-carrying conductors with an equipment grounding conductor in an overall metallic sheath.
   1. Standards:
      a. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
      b. Comply with UL 1569.
      c. Listed for use in Environmental Air space according to NPFA 70 Article 300.
      d. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
   2. Circuits:
      a. Single circuit.
      b. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.
   3. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
   4. Ground Conductor: Insulated.
   5. Conductor Insulation: Type TFN/THHN/THWN-2: Comply with UL 83.
   6. Armor: Steel, interlocked.

2.04 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.

5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Splicing devices for use on No. 14 to No. 10 AWG conductors shall be pressure type such as T & B "STA-KON", Burndy, Reliable or approved equivalent.

D. Wire nuts shall be spring pressure type, insulation 600V, 105 deg. C insulation, up to #8 size. Greater than #6 Cu shall be a compression type connection, 600V insulation, cold shrink tubing, taped, for full insulation value.

E. Pressure crimp-applied ring type (or fork with upturned ends) terminations shall be employed on motor and equipment terminals where such terminals are provided on motor and equipment leads or on all stranded wire terminations using #10 AWG or smaller conductors.

F. Splices, where necessary, shall be made with hydraulically-set “Hy-press” or equivalent crimped connectors. All splices shall be insulated to the full value of the wiring insulation using a cold-shrink kit or the equivalent in built-up materials.

G. Large connectors (lugs) shall be compression, hydraulically set. Lugs furnished on equipment shall be per manufacturer’s recommendations.

H. Underground connections made between bare ground wires or to ground rods shall be exothermically welded, “Cadweld” or equivalent.

I. No aluminum splicing devices or connectors shall be used.

2.05 MISCELLANEOUS PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding. Refer to Division 26 Section “Identification for Electrical Systems” for color-coding requirements.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper for feeders smaller than No. 1/0 AWG; copper or aluminum for feeders No. 1/0 AWG and larger. Stranded for all wire.

B. Branch Circuits: Copper. Stranded for all wire.

C. VFD Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

E. Provide conductors with minimum temperature ratings of 75 degrees C. For high temperature applications, provide conductors with temperature ratings in accordance with the NFPA 70 for the ambient condition.

F. Conductors used for motor connections and connections to vibrating or oscillating equipment shall be extra flexible stranded.

G. All conductors shall be new, in good condition, and delivered in standard coils and reels.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance:

1. Aluminum: Type XHHW-2, single conductors in raceway.
2. Copper: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders 150A and Larger:

1. Aluminum: Type XHHW-2, single conductors in raceway.

2. Copper: Type THHN-THWN, single conductors in raceway.

C. Exposed Feeders Less Than 150A:

1. Copper: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces 150A and Larger:

1. Aluminum: Type XHHW-2, single conductors in raceway.
2. Copper: Type THHN-THWN, single conductors in raceway.

E. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces Less Than 150A:

1. Copper: Type THHN-THWN, single conductors in raceway.

F. Feeders Concealed in below Slabs-on-Grade, and Underground:

1. Aluminum: Type XHHW-2, single conductors in raceway is only allowed where indicated on the Electrical One-Line Diagram on Sheet E5.0.
2. Copper: Type THHN-THWN, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces:

1. Copper: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions:

1. Copper: Type THHN-THWN, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-On-Grade, and Underground:

1. Copper: Type THHN-THWN, single conductors in raceway.
2. Branch circuits shall not be routed in or below Slabs-On-Grade unless approved by the Engineer or serving a recessed floor box.

J. Connections to Luminaires: Metal-Clad Cable, Type MC, maximum of 72 inches.

K. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

L. VFD Output Circuits: Type TC-ER (XLPE) cable with braided shield.

M. Class 1 Control Circuits: Type THHN-THWN, in raceway.

N. Class 2 Control Circuits: Power-limited tray cable, in cable tray.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Run feeders in continuous lengths, without joints or splices. Where continuous runs are impractical; obtain Engineer's approval for splice locations and application.

B. Branch wiring and feeder conductors that are greater than 50-feet in length shall be increased at least one size to compensate for voltage drop. All circuits shall be installed and sized for a maximum 2% voltage drop as calculated using 80% of the supply breaker rating as the load. Adjust conductors and conduit size accordingly for actual field installed conditions.

C. Make joints in branch circuits only where circuits divide.

D. Do not use gutters of panelboards as raceways, junction boxes, or pull boxes for conductors not terminating in said panelboards.

E. Run conduits for emergency power conductors separate from all other wiring.

F. Make splices and terminations in cables with kits and instructions provided by the kit manufacturer. Each splice shall equal the integrity of the cable electrically and environmentally.

G. Bundling Conductors: Bundle conductors in switchboards, panelboards, cabinets, and the like, using nylon ties made for the purpose. Bundle conductors larger than No. 10 in individual circuits. Smaller conductors may be bundled in larger groups.

H. Install all conductors in raceways, unless otherwise indicated.

I. Sizes:

1. Provide conductors no smaller than No. 12 AWG, except for signal or control circuits.
2. Provide No. 10 AWG conductors for home runs on 120-volt, 20-ampere branch circuits, where the conductor length exceeds 100 lineal feet from panelboard to the first device.
3. Provide No. 10 AWG conductors for home runs on 277-volt, 20-ampere branch circuits, where the conductor length exceeds 200 lineal feet from panelboard to the first device.
4. Provide neutral conductors of the same size as the phase conductor(s) for individual branch circuit homeruns.
5. Run dedicated neutral conductor with each branch circuit. Sharing of neutral conductors in multi-circuit homeruns is not acceptable.
    a. Sharing of neutrals would necessitate the use of multiple-pole or tied branch circuit breakers to allow simultaneous disconnecting of current caring conductors in order to comply with NFPA 70 requirements and therefore is unacceptable.
6. Grouping of Multi-Circuit Homeruns: Grouping of multiple circuits into shared conduit homeruns is acceptable where they comply with the quantities and sizes listed in Table “A” below and where homeruns meet the following conditions:
    a. Where conductors are THWN/THHN installed in dry location.
    b. Where raceways are installed in ambient conditions less than 30-Deg C (86-Deg F).
    c. Consider neutral conductors as a current carrying conductor in branch circuits which serve receptacles or electronic ballasted luminaries.
    d. No more than seven conductors shall be installed in conduit except for switch legs and travelers in multi-point switching arrangements.

TABLE A

Number of Current Carrying Conductors in single raceway	Conductor Size for 20Ampere Single Pole Circuit	Conduit Size based on EMT
2 to 3	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
4 to 6	#12 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	3/4" EMT
7 to 9	#10 AWG (THHN 75-Deg) or #12 AWG (THHN 90-Deg)	1” EMT 3/4" EMT

Notes:

1. Conductor and conduit sizes in table above are based on total conductor lengths under 100 lineal feet for 120-volt (200 lineal feet for 277-volt) from panelboard to the first device, 20-ampere branch circuits. Increase conductor and conduit size in accordance with NFPA 70 for longer lengths.

J. Terminations of multiple branch circuit conductors on a single circuit breaker is not acceptable.

K. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

L. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible. Cables that are installed exposed shall not be routed across ceilings or ductwork. They shall be held up against building structure or against permanent support members. They shall be installed in such a manner that they do not interfere with the operation of equipment or removal of ceiling tiles. Nylon tie-wraps shall be installed in such a manner so as to bundle conductors neatly, allowing runouts of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on plans.

M. Intentional or unintentional painting of exposed low voltage or line voltage cabling is prohibited. Ensure that exposed cabling is adequately protected from direct painting or overspray whether painting is required within the electrical specifications or required by other disciplines/trades. Review the painting requirements for all disciplines and provide cabling protection as required. Where exposed cabling is being installed in exposed ceilings or wall spaces that are required to be painted, provide alternate options for cable colors and submittals for such cabling for Engineer to review.

N. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

3.04 WIRE PULLING

A. Pull no conductors into conduits until all Work of a nature which may cause injury to conductors is completed.

B. Follow manufacturers' recommendations for regulating temperature conditions of conductors prior to installation.

C. Exercise care in handling and installing cables to avoid damage. Carefully form cables in equipment pull boxes. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

1. The radius of bending of conductors shall be not less than eighteen (18) times the outside diameter of the conductor insulation.

D. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors. Use ropes of polyethylene, nylon or other suitable non-metallic material to pull in feeders. Metallic ropes are prohibited.

E. Attach pulling lines to conductors by means of insulated woven basket grips or by pulling eyes attached directly to conductors. Do not use rope hitches, or bare steel basket grips. All conductors to be installed in a single conduit shall be pulled in simultaneously.

F. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

G. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance.

H. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.

I. Use manufacturer-approved pulling compound or lubricant where necessary, of non-conducting type. Compounds used must not deteriorate the conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Wiring at Lighting Control Locations: Install a neutral conductor at each switch location controlling line-to-neutral lighting loads.

E. Connectors: Make splices and connections in conductors using approved connectors.

1. Provide lugs and connectors of proper size to match conductor size.
2. Stranded Conductors: Solder-less, bolted pressure or compression connectors.
3. Solid Conductors: Bolted pressure or spring connectors.
4. Motor Lead Pigtails: Crimp lugs with through-bolt fasteners between lugs. Furnish proper sized dies and tools to apply connectors.
5. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
6. Ground Connections: Ground connection materials and installation requirements are specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
7. Wire Nuts:
    a. For up to #8 AWG in size, use spring pressure type, insulation 600V, 105 deg C insulation
    b. For greater than #8 AWG in size, use compression type connection, 600V insulation, cold shrink tubing, taped, for full insulation value.

F. Provide temperature ratings of connectors and splices to match wire rating.

G. Connections for Aluminum Conductors using Mechanical Screw Type Connectors:

1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
2. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
3. Clean the conductor surface using a wire brush and apply a Listed joint compound.
4. Tighten the connection per the connector manufacturer’s recommendation.
5. Wipe off any excess joint compound.

H. Connections for Aluminum Conductors using Mechanical Compression Type Connectors:

1. Connectors shall be dual rated (AL7CU or AL9CU) and Listed by UL for use with aluminum and copper conductors and sized to accept aluminum conductors of the ampacity specified.
2. The lugs shall be marked with wire size, die index, number and location of crimps and shall be suitably color coded. Lug barrel shall be factory prefilled with a joint compound Listed by UL.
3. Using a suitable stripping tool, to avoid damage to the conductor, remove insulation from the required length of the conductor.
4. Clean the conductor surface using a wire brush.
5. Crimp the connection per the connector manufacturer’s recommendation.
6. Wipe off any excess joint compound.

I. Termination of Aluminum Conductor to Aluminum Bus:

1. Prepare a mechanical connection conforming to G or H above.
2. Hardware:
    a. Bolts: Anodized aluminum alloy 2024-T4 and conforming to ANSI B18.2.1 and to ASTM B211 or B221 chemical and mechanical property limits.
    b. Nuts: Aluminum alloys 6061-T6 or 6262-T9 and conforming to ANSI B18.2.2.

c. Washers: Flat aluminum alloy 2024-T4, Type “A” plain, standard wide series conforming to ANSI B27.2.

d. Lubricate and tighten the hardware as per the manufacturer’s recommendations.

J. Termination of Aluminum Conductor to Copper Bus:

1. Prepare a mechanical connection conforming to G or H above.

2. Hardware:

a. Bolts: Plated or galvanized medium carbon steel; heat treated, quenched and tempered equal to ASTM A-325 or SAE grade 5.

b. Nuts: Heavy semi-finished hexagon, conforming to ANSI B18.2.2, threads to be unified coarse series (UNC), class 2B.

c. Washers: Steel; Type A plain standard wide series conforming to ANSI B27.2.

d. Belleville conical spring washers: hardened steel, cadmium plated or silicone bronze.

e. Lubricate and tighten the hardware as per the manufacturer’s recommendations.

K. Termination of Aluminum Conductor to Equipment Not Equipped for Termination of Aluminum Conductor:

1. Prepare compression connection using an adapter Listed by UL for the purpose or by pigtailing a short length of suitable size of copper conductor to the aluminum conductor with a compression connector Listed by UL.

2. Provide an insulating cover over adapter body or the compression connector.

3. Terminate the adapter or the pigtail on to the equipment per manufacturer’s recommendation.

3.07 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.08 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.09 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for one minute.

2. Perform continuity test to insure correct cable connection.

3. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors of No. 2 AWG and larger for compliance with requirements.

4. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

5. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

C. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 0519

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. NFPA 70 and IEEE C2 include basic grounding requirements for electrical safety. This Section supplements the minimum safety requirements of the Code with requirements for additional grounding and with optional grounding methods and materials for both power and electronic systems.

B. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of product indicated.

1.03 INFORMATIONAL SUBMITTALS

A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Grounding arrangements and connections for separately derived systems.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems and test wells, based on NETA MTS.
    a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
    b. Include recommended testing intervals.

1.05 QUALITY ASSURANCE

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 NFPA 70.

D. Comply with IEEE C2.

E. Comply with ANSI-J-STD-607-A.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.

3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

2.02 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
6. Main Bonding Jumper: Stranded copper conductors sized as indicated on Drawings.
7. Grounding Electrode Conductor: Stranded copper conductors sized as indicated on Drawings.
8. Common Grounding Electrode Conductor: Stranded copper conductors sized as indicated on Drawings.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

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

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

G. Conduit Hubs: Mechanical type, terminal with threaded hub.

H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

I. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

2.04 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8-inch diameter by 96 inches long.

B. Other grounding electrodes permitted for grounding per NFPA 70 include:

1. Metal Underground Water Pipe: A metal underground water pipe in direct contact with the earth for a minimum of 10-feet and electrically continuous.

2. Concrete-Encased Electrode (Ufer Ground): Bare copper conductor not smaller than No. 4 AWG a minimum of 20-feet long encased in the center of the concrete foundation that is in direct contact with the earth.

3. Building Steel: The hold-down bolts securing the structural steel column shall be connected to the concrete-encased electrode.

PART 3 - EXECUTION

3.01 APPLICATIONS

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

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.

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 Ground Rods: Welded connectors.

5. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Dry-Type Transformers: Install an insulated grounding conductor from the common point of connection of the transformer secondary neutral point and the transformer enclosure to the following:

1. The nearest grounding electrode per NFPA 70, including but not limited to building steel where available.

2. The grounding bus of the common electrode grounding system, located in the electrical equipment room.

3.04 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

1. Bond to each device, box, and luminaire, unless otherwise indicated.

2. Conductor insulation of the same rating as the phase conductors, for all feeders and branch circuits. Install the grounding conductors in the raceway with related phase and neutral conductors.

3. Where parallel conductors in separate raceways occur, provide a grounding conductor in each raceway that meets requirements of NFPA 70.

B. Enclosures: Install an insulated grounding conductor from grounding bushings to the frame of the enclosure, ground bus, and equipment grounding strap where each occurs. Install grounding bushings on all raceways connecting electrical enclosures constructed of separate enclosure panels, which are not integrally welded together.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.05 INSTALLATION

A. All circuits shall have a separate grounding conductor.

B. Provide permanent service neutral and equipment grounding in accordance with NFPA 70 and subject to the following additional requirements.

C. Comply with mounting and support requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Connect the service neutral and equipment ground to a common point within the metallic enclosure containing the main service disconnecting means. Equipment grounds and the identified neutral of the wiring system shall not be interconnected beyond this point in the interior wiring system. From the common point of connection of the service neutral and the equipment ground, run in non-magnetic conduit a grounding electrode conductor without joint or splice to the grounding electrode system and connect it with an approved bolted pressure clamp.

E. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

F. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

2. For grounding electrode system, install at least three rods at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

G. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
4. Where expansion joints or telescoping joints occur, provide bonding jumpers.

H. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

I. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install bare copper grounding conductors from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

J. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.06 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 1000 kVA and Less: 5 ohms.

2. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

3. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm.

4. Substations and Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.02 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. RMC: Rigid metal conduit.

E. RNC: Rigid nonmetallic conduit.

F. RSC: Rigid steel conduit.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

C. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.
5. Concrete bases for equipment.

1.05 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.; a division of Cooper Industries.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Tyco International, Ltd.
    g. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

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

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical 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 malleable iron.

E. Device Box Mounting Brackets and Stabilizer: Factory-fabricated sheet steel brackets for support of device boxes adjacent to or between studs.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Cooper B-Line, Inc.
    b. ERICO International Corporation.

F. Through-Stud Cable and Raceway Support Clips: Factory-fabricated spring steel clip for cables or raceways where run horizontally through metal studs.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    a. Cooper B-Line, Inc.
    b. ERICO International Corporation.

G. Roof-mounted Raceway Support Blocking: Factory-fabricated support blocking for use under roof-mounted raceways. Wedge-shaped blocking constructed of 100% recycled UV-resistant Rubber with integral galvanized steel strut to accept raceway support clips.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper B-Line C-Port series components or a comparable product by one of the following:
    a. Cooper B-Line, Inc.
    b. ERICO International Corporation.

H. Tee Bar Grid Box Hanger: Factory-fabricated metal electrical box hanger for supporting boxes at locations between ceiling system t-grid components. Height adjustable for various electrical box depths. Attached to ceiling tee bar with screws or integral clamp for stability. Includes tab for independent support wire attachment.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-Line, Inc.

b. ERICO International Corporation.

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

J. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.

2) Empire Tool and Manufacturing Co., Inc.

3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

6. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. All electrical raceways shall be hung independently from the building structure with UL Listed and approved materials. Hangers and supports suspending from the support systems of other trades' work shall not be permitted. The use of tie wire for support or fastening of any raceway system is prohibited.

C. Supports for raceways shall be of materials compatible with the raceway, of malleable iron, spring steel, stamped steel or other approved material. Die-cast fittings are not permitted for supports.

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

E. Minimum Hanger Rod Size for Raceway Supports: Minimum rod size shall be 1/4 inch in diameter, 20 threads per inch. Rods shall be furnished with a corrosion-resistant finish.

F. Single Raceways or Cables:

1. For Raceways 1-1/4-inch and smaller: Install adjustable steel band hanger suspended on threaded rod.
2. For Raceways larger than 1-1/4-inch: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods. Size trapeze members, including the suspension rods, based on the support required for the size, and loaded weight of the conduits.
    a. Secure raceway or cable to support with two-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.
3. For Individual Raceways on Building Walls: Secure with two hole galvanized malleable iron or stamped steel pipe strap or “minerallac” 2-piece straps. The straps are to be anchored by an approved means such as expansion anchors, toggle bolts, through bolts, etc. Where required by codes or other standards, provide spacers behind mounting clamps to space conduits off walls.
4. For Individual Raceways on Building Steel: Secure with clamp supports

G. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system suspended on threaded rods, where multiple raceways are run vertically or horizontally at the same elevations. Size trapeze members, including the suspension rods, based on the support required for the smallest conduit to be supported. Size 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.

H. 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.

3.02 SUPPORT INSTALLATION

A. Comply with NFPA 70, NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Fasten junction, pull and devices boxes securely to the building construction, independent of raceway system.

C. Install Device Box Mounting Brackets supported between two studs where boxes are not located adjacent to stud or where multiple boxes are located between studs.

D. Install Device Box Stabilizer where single box is located adjacent to stud.

E. Install Through-Stud Cable and Raceway Support Clips where cables or raceways run horizontally through metal studs.

F. Install Tee Bar Grid Box Hanger supported between two ceiling grid tee bars where devices boxes are located flush in recessed suspended ceilings.
    1. Install at least one independent support rod from box hanger to structure.

G. Install Roof-mounted Raceway Support Blocking where raceways run on across roofing.
    1. Coordinate installation of roof supports with items specified in Division 07 Section "Roof Accessories." Provide products compatible with rooftop materials included in the Work.

H. Provide minimum of two lock nuts per threaded support rod except where lock nut tightens against a threaded socket, one locknut may be used.

I. Support raceways at a distance above suspended ceilings to permit removal of ceiling panels and luminaires.
    1. No raceway shall be installed on acoustic tile ceiling tees and support wire, or in any location that will impair the functioning, access or code-required clearances for any equipment or system.

J. Locate raceways so as not to hinder access to mechanical equipment.

K. Do not secure conductors, raceways, or supports to suspended ceiling hanger rods or wires.

L. 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.

M. Where lighting fixtures, appliances or wiring devices are to be suspended from ceiling outlet boxes, they shall be provided with 3/4" rigid conduit pendants. Outlet boxes shall be malleable iron, provided with self-aligning covers with swivel ball joint (minimum 125 lb. support) and No. 14 gauge steel locking ring. Provide safety chain between building structure and ballast housing of light fixtures for all fixtures, appliances or devices greater than 10 lbs. weight. Fixtures shall be installed plumb and level. Cover pendants shall be finished to match fixtures.

N. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical 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. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. 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. Attachment to gypsum wall board is not acceptable as sole support means.

O. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars. Verify reinforcing locations with Structural Engineer. X-Ray existing concrete structures as required.

3.03 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 3 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.04 PAINTING

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

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

END OF SECTION 26 0529

SECTION 26 0533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.02 DEFINITIONS

A. BAS: Building Automation System.

B. EMT: Electrical metallic tubing.

C. ENT: Electrical non-metallic tubing.

D. EPC: Electrical Plastic Conduit

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. FMC: Flexible metal conduit.

G. GRC: Galvanized rigid steel conduit.

H. IMC: Intermediate metal conduit.

I. LFMC: Liquidtight flexible metal conduit.

J. LFNC: Liquidtight flexible nonmetallic conduit.

K. NBR: Acrylonitrile-butadiene rubber.

L. RAC: Rigid aluminum conduit.

M. RMC: Rigid metal conduit.

N. RNC: Rigid nonmetallic conduit (PVC)

O. RSC: Rigid Steel conduit.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

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

1.04 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. Anamet Electrical, Inc.
   4. Calbond.
   5. Electri-Flex Company.
   6. Orbit Industries, Inc.
   7. O-Z/Gedney; a brand of EGS Electrical Group.
   8. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
   9. Plasti-Bond.
   10. Republic Conduit.
   11. Robroy Industries.
   12. Sentinal Conduit.
   13. Southwire Company.
   14. Thomas & Betts Corporation.
   15. Western Tube and Conduit Corporation.
   16. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RSC: Comply with ANSI C80.1, UL 6, and NEMA FB 2.10; Galvanized rigid steel, each length with a coupling on one end and thread protector on opposite end.

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

E. Fittings for RSC and IMC: Provide factory made threaded couplings of same material as the conduit.
   1. Molded thermoplastic insulating bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. In wet locations, provide watertight hubs for conduit entry into enclosures.
   2. Thermoplastic insulated grounding bushing on all conduits where grounding bushings are required, with locknuts inside and outside the enclosure. In wet locations provide watertight hubs for conduit entry into enclosures.
   3. Expansion joints: O-Z/Gedney or acceptable submission, with internal ground and external bonding jumper.
      a. Expansion fitting: Type AX.
      b. End type expansion fitting: Type EXE.
      c. Deflection fitting: Type DX.
      d. Pull box fitting: Type EXPB.
      e. Combination expansion/deflection fitting: Type AXDX.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.

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

H. FMC: Comply with UL 1; zinc-coated steel.

I. LFMC: Flexible steel conduit with flame retardant PVC jacket and copper grounding strand; comply with UL 360.

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

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.

2. Fittings for EMT:

a. Material: Steel.

b. Type: Mechanical set screw.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, 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.

K. Joint Compound for IMC, RSC, or RAC: 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.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.

2. Anamet Electrical, Inc.

3. Arnco Corporation.

4. CANTEX Inc.

5. CertainTeed Corp.

6. Condux International, Inc.

7. Electri-Flex Company.

8. Kraloy.

9. Lamson & Sessions; Carlon Electrical Products.

10. Niedax-Kleinhuis USA, Inc.

11. RACO; a Hubbell company.

12. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. ENT: Comply with NEMA TC 13 and UL 1653.

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

E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper B-Line, Inc.

2. Hoffman; a Pentair company.
3. Mono-Systems, Inc.
4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. 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.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.04 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Mono-Systems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2.05 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. Orbit Industries, Inc.
12. O-Z/Gedney; a brand of EGS Electrical Group.
13. RACO; a Hubbell Company.
14. Robroy Industries.
15. Spring City Electrical Manufacturing Company.
16. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
17. Thomas & Betts Corporation.

18. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

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, ferrous alloy, Type FD, with gasketed cover.

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

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

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

1. Construct boxes from code gauge sheet steel no lighter than 14 gauge with overlapped riveted or welded corners and with edges turned to receive trim.

2. Construct covers from same gauge as box with screw fasteners. Sectionalize boxes over 864 square inches.

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

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

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep .

K. Gangable boxes are prohibited.

L. 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.

M. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box 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.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

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

1. Exposed Conduit: RSC or IMC.

2. Concealed Conduit, Aboveground: RSC or IMC.

3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased unless noted otherwise.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed and Subject to Physical Damage: RSC or IMC. Raceway locations include the following:
      a. Loading dock.
      b. Areas used for traffic of mechanized carts, forklifts, and pallet-handling units.
      c. Mechanical rooms.
      d. Ag Mechanic Shops.
      e. Gymnasiums.
      f. Exposed below 8'-0" a.f.f.
   3. Exposed and Subject to Pool Chemical Environment: RNC. Raceway locations include natatorium space, pool pump areas, chemical treatment room, etc.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: RSC or IMC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways 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 mechanical set screw, steel fittings. Comply with NEMA FB 2.10.
   4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

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

F. Install surface raceways only where indicated on Drawings.

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

H. Do not install nonmetallic conduit in environmental air plenums.

I. Junction and Pull Boxes: Sheet steel boxes, unless otherwise indicated.
   1. Provide boxes no smaller than 4 inches square and 2-1/8 inches deep.
   2. Size all junction and pull boxes in accordance with the NFPA 70, unless project conditions dictate use of larger boxes.
   3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

J. Outlet and Device Boxes: Sheet steel boxes, unless otherwise indicated.
   1. For Lighting Fixture Outlets: 4 inch square with raised fixture ring.
   2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use

boxes 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.

3. Boxes in Hazardous Areas: Cast metal boxes with appropriate sealing fittings.

K. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes with gasketed covers and threaded hubs.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs and 1 inch away from perpendicular runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

1. Change from RNC to RSC or IMC before rising above the floor.

2. Protect conduit openings with plastic caps approved for this purpose.

F. Install no more than the equivalent of three 90-degree bends and a maximum of 150 feet between pull points in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

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

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

I. All exposed conduit shall be installed on strut system racks with runs parallel or perpendicular to walls, structural members or intersections of vertical planes and ceilings, with right angle turns consisting of cast metal fittings or symmetrical bends unless otherwise shown. All conduit shall have supports spaced not more than eight feet apart. Supports shall also be provided within 36” of all boxes, bends, and termination points. Where termination points are free standing, support shall be provided within 12”. Conduits randomly routed will not be accepted. Conduits shall be concealed in open structure (no finished ceiling) where possible and painted to match.

J. Level and square raceway runs, and install at proper elevations and required heights. Hold tight to structure wherever possible, to maximize available space and not restrict other trades. Do not attach or support from roof deck.

K. Raceways Embedded in Slabs: Only allowed when connecting to floor boxes embedded in concrete slab.

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 raceways to reinforcement at maximum 10-foot intervals.

2. Do not cross building expansion joints with embedded conduits.

3. Arrange raceways 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.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.

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 raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

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

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. EMT terminations at junction boxes, panelboards, etc. shall be made with case hardened locknuts and appropriate fittings, with insulated throat liners. Insulating terminations shall be manufactured as a single unit. The use of split sleeve insulators is not permitted.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. 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.

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

U. Install pull wires in empty raceways. 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. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.

2. Surface metal raceways and all components and fittings shall be furnished by a single manufacturer. All trim and cover fittings, flush feed boxes, splices, outlet fittings, etc. necessary for a complete installation shall be provided.

3. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 36 inches, or 6 inches from ends an don either side of a corner, and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Exposed raceways installed in exterior locations shall receive one coat of primer, two coats finish paint after preparation of galvanizing, color selected by Architect. Exposed raceways in interior painted areas shall be similarly painted.

X. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, 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 raceway sealing fittings according to NFPA 70.

Y. Install devices to seal raceway 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 raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where an underground service raceway enters a building or structure.

3. Where otherwise required by NFPA 70.

Z. Conduit shall be installed in such a manner so as to ensure against collection of trapped condensation. All runs of conduit shall be arranged so as to be devoid of traps. Trapped conduit runs shall be provided with explosion proof drains at low points. Runs of conduit between junctions shall not have more than the equivalent of three 90° bends.

AA. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

BB. 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 conduit 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. Provide copper ground bonding jumper across expansion fitting.

CC. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed luminaires. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

DD. 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 bottom of box unless otherwise indicated.

EE. 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 surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

FF. Locate boxes so that cover or plate will not span different building finishes.

GG. 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.

HH. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel, unless intumescent putty pads are installed according to Division 07 Section "Firestopping."

II. Recessed Boxes in Fire-Rated Partitions: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation, unless otherwise indicated in the installation requirements specified in Division 07 Section "Firestopping."

JJ. Recessed Boxes in partitions around Acoustically-Sensitive Spaces: For boxes located on opposite sides of same partition do not install boxes back-to-back; separate boxes with a minimum of 24 inch separation. Acoustically-Sensitive Spaces include, but are not limited to, the following:

1. Conference rooms, meeting rooms and similar spaces.
2. Classrooms, training rooms and similar spaces.
3. Interview rooms, consultation rooms and similar spaces.
4. Auditoriums, lecture rooms, and similar spaces.

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

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

3.03 FIRESTOPPING

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

3.04 PROTECTION

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

3.05 CONNECTIONS

A. Ground raceways and boxes according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.06 IDENTIFICATION

A. Identify raceways and boxes as specified in Division 26 Section “Identification for Electrical Systems”.

3.07 SEGREGATION OF WIRING SYSTEMS

A. Segregation of wiring systems shall not be compromised by the use of common pullboxes, wireways, cabinets or any other type of enclosure.

B. The raceway system for each feeder shall be a separate system completely fault isolated from all other raceway systems.

C. The raceway system for the branch circuits of each panelboard shall be a separate system completely fault isolated from all other raceway systems.

D. In systems operating at more than 300 volts between phase conductors, and where different phase conductors are to be run to a common device or outlet box, provide code gauge barrier equal to box gauge between conductors so that two different phase wires will not be in the same compartment.

3.08 CLEANING

A. On completion of raceway installation but before any cable is installed, perform the following:

1. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. On completion of box, enclosure, and cabinet installation but before any cable or wiring devices are installed, inspect interior of boxes and perform the following:

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 0533

SECTION 26 0543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

B. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 DEFINITION

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

B. Duct: An underground raceway. This term may be used interchangeably with the term raceway.

C. Duct Bank: Two or more raceways grouped together, irrespective of duct material or encasement material.

D. ENT: Electrical Non-Metallic Tubing

E. EPC: Electrical Polyvinyl Chloride (PVC) Conduit

F. RMC: Rigid metal conduit.

G. RNC: Rigid nonmetallic conduit.

H. RSC: Rigid Steel conduit.

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

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes.
4. Warning tape.

C. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include dimensioned plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder details.
5. Grounding details.
6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

D. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
3. Grounding details.
4. Dimensioned locations of cable rack inserts and pulling-in and lifting irons.

1.04 INFORMATIONAL SUBMITTALS

A. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

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

C. Source quality-control test reports.

D. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

1.07 COORDINATION

A. Coordinate layout and installation of ducts, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

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

PART 2 - PRODUCTS

2.01 METAL CONDUITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Calbond
5. Electri-Flex Company.
6. Orbit Industries, Inc.
7. O-Z/Gedney; a brand of EGS Electrical Group.

8. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
9. Plasti-Bond
10. Republic Conduit.
11. Robroy Industries.
12. Sentinel Conduit.
13. Southwire Company.
14. Thomas & Betts Corporation.
15. Western Tube and Conduit Corporation.
16. Wheatland Tube Company; a division of John Maneely Company.

B. RSC: Rigid Steel Conduit, Galvanized. Comply with ANSI C80.1.

C. PVC-Coated, Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

C. Underground Plastic Utilities Duct: Type EPC-40-PVC and Type EPC-80-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 and UL 514B by same manufacturer as duct.

D. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, as indicated for each service.
4. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches.
   b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
6. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
   a. Type and size shall match fittings to duct or conduit to be terminated.
   b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Color: Gray.
2. Configuration: Units shall be designed for flush burial and have integral closed bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC," "TELEPHONE," or as indicated for each service.
6. 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.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armorcast Products Company.

b. Carson Industries LLC.

c. CDR Systems Corporation.

d. NewBasis.

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armorcast Products Company.

b. Carson Industries LLC.

c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

2.05 PRECAST MANHOLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carder Concrete Products.

2. Christy Concrete Products.

3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.

5. Riverton Concrete Products; a division of Cretex Companies, Inc.

6. Utility Concrete Products, LLC.

7. Utility Vault Co.

8. Wausau Tile, Inc.

B. Comply with ASTM C 858 and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.

b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.

c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

C. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

D. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.06 UTILITY STRUCTURE ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Bilco Company (The).
   2. Campbell Foundry Company.
   3. Carder Concrete Products.
   4. Christy Concrete Products.
   5. East Jordan Iron Works, Inc.
   6. Elmhurst-Chicago Stone Co.
   7. McKinley Iron Works, Inc.
   8. Neenah Foundry Company.
   9. NewBasis.
   10. Oldcastle Precast Group.
   11. Osburn Associates, Inc.
   12. Pennsylvania Insert Corporation.
   13. Riverton Concrete Products; a division of Cretex Companies, Inc..
   14. Strongwell Corporation; Lenoir City Division.
   15. Underground Devices, Inc.
   16. Utility Concrete Products, LLC.
   17. Utility Vault Co.
   18. Wausau Tile, Inc.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inches.
      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
      b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
   2. Cover Legend: Cast in. Selected to suit system.
      a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
      b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.
      c. Legend: "SIGNAL" for communications, data, and telephone duct systems.
   3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
      a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
   1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.

F. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

H. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

I. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

J. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

K. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

L. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two (2) required.

2.07 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. 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 a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the 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

3.01 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 Architect 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 and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Remove and stockpile topsoil for reapplication according to Division 31 Section "Site Clearing."

3.02 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, installed in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Paved Paths, Walks, Driveways, and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.03 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 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. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.04 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

1. Beyond building perimeter, provide bentonite “trench plug” that extends at least 5 feet out from the face of the building’s exterior.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

3.05 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Depths of bury shall be:

1. 42” minimum to top of primary ducts
2. 36” minimum to top of secondary ducts
3. 36” minimum to top of branch exterior circuits

4. 36” minimum to top of telephone/communications ducts

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.

D. Joints: Use solvent-cemented joints in ducts 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. Duct Entrances to Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.

2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

F. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.

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

H. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares.

I. Concrete-Encased Ducts: Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Division 31 Section “Earth Moving” for pipes less than 6 inches in nominal diameter.

2. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Place separators within 24 inches of duct ends. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

3. Concrete: All concrete used in duct bank construction shall be 3000 PSI minimum 28-day compressive strength unless otherwise noted in accord with latest ACI standards complying with Division 03 Section "Cast-in-Place Concrete." Testing of concrete shall be the responsibility of the Contractor.

4. Concreting Pouring 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 ducts as their 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 18 inches into concrete on both sides of joint near corners of envelope.

5. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. 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.

6. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall.
7. Concrete Reinforcement: Reinforce concrete-encased duct banks 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 walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
9. Install backfill as specified in Division 31 Section "Earth Moving."
    a. Backfill shall be accomplished with clean debris free earth and tamped at 12-inch intervals so as to avoid earth sinks along the trench.
    b. Backfill trenches only after conduit has been inspected by Agencies, Engineer and Owner, tested, and locations of lines have been recorded on Record Drawings. Provide at least one week's written notification to all parties of impending work that needs to be reviewed.
    c. Backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.
    d. Backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.
    e. Concrete for concrete encasement shall cure a minimum of 3 days prior to backfill.
10. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
11. Stub-Ups: Use manufactured PVC-coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
12. Detectable Warning Tape: Bury detectable warning tape approximately 18 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the 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.

J. Direct-Buried Duct Banks:

1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."
    a. Backfill shall be accomplished with clean debris free earth and tamped at 12-inch intervals so as to avoid earth sinks along the trench.

b. Backfill trenches only after conduit has been inspected by Agencies, Engineer and Owner, tested, and locations of lines have been recorded on Record Drawings. Provide at least one week's written notification to all parties of impending work that needs to be reviewed.

c. Backfill below paved areas shall be brought to proper grade to receive the sub-base and paving. No paving shall be placed on uncompacted fill.

d. Backfill below sodded or seeded areas shall be brought to within six inches of finished grade. The remaining six inches shall be backfilled with clean soil.

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts 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 ducts and hand tamp. Firmly tamp backfill around ducts 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 as specified in Division 31 Section "Earth Moving."

6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.

7. Width: Excavate trench 3 inches wider than duct on each side.

8. Set elevation of bottom of duct bank below the frost line.

9. Stub-Ups: Install manufactured PVC-coated rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete 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 equipment base or foundation. Install insulated grounding bushings on terminations at equipment.

10. Detectable Warning Tape: Bury detectable warning tape approximately 18 inches above all direct bury duct banks. Align tape parallel to and within 3 inches of the 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.

3.06 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

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

B. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.

2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.

3. Install handholes with bottom below the frost line.

4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

5. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms,as required for installation and support of cables and conductors and as indicated.

F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.07 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 ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the 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 so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. 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 the enclosure.

E. Field-cut openings for ducts and 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.

F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.

2. Dimensions: 10 inches wide by 12 inches deep.

3.08 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.09 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 ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

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

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 26 0543

SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   4. Underground-line warning tape.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Miscellaneous identification products.

B. Related Sections include the following:
   1. Division 26 Section "Wiring Devices" for wall plates and wiring device identification requirements.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each electrical identification product indicated.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

D. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.03 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

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

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

1.04 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 - PRODUCTS

2.01 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Wraparound Labels: Write-on, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Brady Corporation.
   b. Gardner.
   c. T&B.
2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield 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.

2.02 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical 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 degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
4. Tape to be minimum 6 mil thick and 6-inches wide with aluminum backing to be detectable underground using a non-ferrous locator.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.04 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR ## INCHES." Verify work space required for specific project conditions with NFPA 70 and replace “##” in previous sentence with appropriate distance.
3. Arc Flash Warning and Instruction: “WARNING – ARC FLASH AND SHOCK HAZARD. WEAR APPROPRIATE PPE.” Determine appropriate protective clothing and personal protective equipment (PPE) for the task from NFPA 70E.

2.05 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

1. Power Circuits:

a. Normal: White lettering on Black background.

b. Emergency Systems (Life Safety) and Legally Required Standby: White lettering on Red background.

c. Optional Standby: White lettering on Red background.

2.06 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, 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, 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, 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.

2.07 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. 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

3.01 INSTALLATION

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

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

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

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Conductor Color-Coding Key: Install Instructional Label denoting the conductor color-coding scheme on all panelboards, distribution boards, switchboards, switchgear, motor-control center and similar equipment.

F. All conductors shall be identified by color code and by means of labels placed on conductors in junction boxes and at terminal points with labels indicating source, circuit No. or terminal No.

G. Conductor Color-Coding for Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied to conductors or for sizes larger than No. 8 AWG, if authorities having jurisdiction permit, field applied.
2. Colors for Grounding Conductors:
    a. Equipment Grounding Conductor: Green.
3. Colors for 208/120-V Wye Systems:
    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Grounded Conductor (Neutral): White
4. Colors for 480/277-V Wye Systems:
    a. Phase A: Brown.
    b. Phase B: Purple.
    c. Phase C: Yellow.
    d. Grounded Conductor (Neutral): Gray
5. Control Wiring: Red, or as indicated.
6. D.C. Wiring:
    a. Positive: Light Blue
    b. Negative: Dark Blue
7. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Underground-Line Warning Tape: During backfilling of trenches install continuous detectable underground-line warning tape approximately 18 inches above all concrete-encased ducts and direct bury duct banks. Align tape parallel to and within 3 inches of the 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.

3.02 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch- high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Power.
2. Power.

C. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    a. Power transfer switches.
    b. Main-Tie-Main Switchboards.
    c. Controls with external control power connections.
5. For equipment requiring workspace clearance according to NFPA 70, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
6. Arc Flash Warning Labels: Apply label to door or cover at all access point of equipment including, but not limited to, the following:
    a. Disconnect switches.
    b. Electrical switchgear and switchboards.
    c. Emergency system boxes and enclosures.
    d. Enclosed circuit breakers.
    e. Meter Sockets and assemblies.
    f. Motor starters.
    g. Panelboards.
    h. Power transfer equipment (ATS).
    i. Transformers.
7. Available Fault Current Field Marking: Apply label to cover of existing and new service equipment enclosure with the date in which the fault current was calculated and the available fault current as determined by the OCPD coordination study. Table 1 below lists a typical example of label format, coordinate project specific requirements with Drawings.

Table 1 (Example Only)

MAX. AVAILABLE FAULT: XX,XXXA DATE: X/X/XX

H. Junction Boxes and Pull Boxes: Identify voltage, source, and circuit number(s) on cover of pull and junction boxes with hand-written legible block lettering using black permanent marking pen.

I. Instruction Signs:

1. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and kirk key controlled breakers.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. 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 or more are required, use label height as required to accommodate 3/8-inch-high letters.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

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

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchboards.

e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

f. Transfer switches.

g. Emergency system boxes and enclosures.

h. Enclosed switches.

i. Enclosed circuit breakers.

j. Enclosed controllers.

k. Variable-speed drives.

l. Push-button stations.

m. Power transfer equipment.

n. Contactors.

o. Remote-controlled switches, dimmer modules, and control devices.

p. Power-generating units.

q. Monitoring and control equipment.

3. Provide identification for each feeder overcurrent protective device in each switchgear, switchboard, distribution panelboard, motor control center, and any other similar equipment furnished under this Division, identification as to the specific load that it serves.

4. Provide brass phase rotation tags for each 3-phase motor securely attached to the equipment.

END OF SECTION 26 0553

SECTION 26 0573
OVERCURRENT PROTECTIVE DEVICE STUDIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes requirements for computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on Engineer's review of submitted results of the protective device coordination study.

1. Coordination of series-rated devices is not permitted.
2. Delegated Design Requirements for Arc Flash Hazard Analysis.

1.02 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds.

C. Delegated Design for Arc Flash Hazard Analysis: Prepare computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Electrical Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Product Data: For computer software program to be used for studies.

C. Simultaneous Action Submittals: The following action submittals shall be made in conjunction with the approval process for system protective devices specified in other Division 26 Sections. The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section "Submittal Procedures" to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner. The following submittals shall be in digital form:

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.
4. Arc flash study input data, including completed computer program input data sheets.
5. Arc Flash Hazard Analysis Report.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399. For arc flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For the overcurrent protective devices to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. The following parts from the Protective Device Coordination Study Report:
    a. One-line diagram.
    b. Protective device coordination study.
    c. Time-current coordination curves.
    d. Coordination setting schedules.
2. Power system data.

B. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.

C. Operation and Maintenance Procedures: In addition to items specified in Division 01 Section “Closeout Submittals,” provide maintenance procedures for use by Owner’s personnel that comply with requirements in NFPA 70E.

1.06 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for performing Arc Flash Hazard Calculations.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. SKM Systems Analysis, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 242 and IEEE 399 for fault-current and overcurrent protective device coordination studies.

B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

2.03 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive Summary

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Short-Circuit Study Input Data: As described in "Power System Data" Article in the Evaluations.

E. Short-Circuit Study Output:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
   a. Voltage.
   b. Calculated symmetrical fault-current magnitude and angle.
   c. Fault-point X/R ratio.
   d. No AC Decrement (NACD) ratio.
   e. Equivalent impedance.
   f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
   g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

2.04 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

A. Executive summary.

B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output: As specified in "Short-Circuit Study Output" Paragraph in "Short-Circuit Study Report Contents" Article above.

F. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
   a. Phase and Ground Relays:
      1) Device tag.
      2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
      3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:
   1) Adjustable pickups and time delays (long time, short time, ground).
   2) Adjustable time-current characteristic.
   3) Adjustable instantaneous pickup.
   4) Recommendations on improved trip systems, if applicable.
c. Fuses: Show current rating, voltage, and class.

G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
   a. Power utility's overcurrent protective device.
   b. Medium-voltage equipment overcurrent relays.
   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
   f. Cables and conductors damage curves.
   g. Ground-fault protective devices.
   h. Motor-starting characteristics and motor damage points.
   i. The largest feeder circuit breaker in each motor-control center and panelboard.
5. Provide adequate time margins between device characteristics such that selective operation is achieved.
6. Comments and recommendations for system improvements.

2.05 ARC FLASH STUDY REPORT CONTENT

A. Executive summary.
B. Study descriptions, purpose, basis and scope.
C. One-line diagram, showing the following:
1. Protective device designations and ampere ratings.
2. Cable size and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, and panelboard designations.
D. Study Input Data: As described in “Power System Data” Article.
E. Protective Device Coordination Study Report Contents: As specified in “Protective Device Coordination Study Report Contents” Article above.

F. Arc-Flash Study Output:
   1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
      a. Voltage.
      b. Calculated symmetrical fault-current magnitude and angle.
      c. Fault-point X/R ratio.
      d. No AC Decrement (NACD) ratio.
      e. Equivalent impedance.
      f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
      g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

G. Incident Energy and Flash Protection Boundary Calculations:
   1. Arcing fault magnitude.
   2. Protective device clearing time.
   3. Duration of arc.
   4. Arc-flash boundary.
   5. Working distance.
   6. Incident energy.
   7. Hazard risk category.
   8. Recommendations for arc-flash energy reduction.

H. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

I. Equipment specific Arc Flash Warning Labels.

2.06 ARC-FLASH WARNING LABELS

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Produce a 3.5-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
   1. Flash Hazard Boundary
   2. Short Circuit Current Available
   3. Shock Hazard when Cover is Removed
   4. Limited Approach Boundary
   5. Restricted Approach Boundary
   6. Prohibited Approach Boundary
   7. PPE Requirements, including the following:
      a. Hazard Risk Category
      b. Required Minimum Arc Rating of PPE in cal/cm^2
      c. Clothing Description
   8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled.
    a. Coordination study shall accompany submission of relevant equipment submittals.

3.02 POWER SYSTEM DATA

A. Delegated Design System Analyst performing the short-circuit, protective device coordination study and arc flash hazard analysis shall furnish the Contractor with a list of required data immediately after award of the contract. Contractor shall expedite collection of the data to ensure completion of the study and analysis as required.

B. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.

C. Source combination shall include present and future motors and generators indicated in the documents.

D. If applicable, include fault contribution of existing motors in the study and analysis.

E. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator short-circuit current contribution data, including short-circuit reactance, rated kilovolt amperes, size, rated voltage, and X/R ratio.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity, impedance, lengths, and conductor material.
    g. Motor horsepower and code letter designation according to NEMA MG 1.
    h. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
    i. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Time-current-characteristic curves of devices indicated to be coordinated.

g. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY

A. A short-circuit current ratings indicated in the Contract Documents are based on Fault-Current study prepared by the Engineer during design and are based on available information and anticipated feeder lengths. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Electric Utility’s supply termination point.
2. Service Entrance Equipment.
3. Switchboard bus.
4. Distribution panelboard.
5. Branch circuit panelboard.
6. Enclosed Fused Switch.
7. Enclosed Circuit Breaker.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculate short-circuit currents according to IEEE 551.

E. In addition to IEEE 551 short-circuit current calculations, calculate the short-circuit currents at the following:

1. Motor Controllers: Rated greater than or equal to 2hp at 300V or more.
2. Air-Conditioning and Refrigerating Equipment Controllers: Including, but not limited to, equipment supplied from a branch circuit protected at greater than 60A.
3. Elevator Controllers.

F. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:
   a. ANSI C57.12.10.
   b. ANSI C57.12.22.
   c. ANSI C57.12.40.
   d. IEEE C57.12.00.
   e. IEEE C57.96.

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

G. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram, including existing and new Service Entrance equipment.

H. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Ensure that short-circuit withstand ratings are equal to or higher than the calculated ½-cycle symmetrical fault current for the following:
   a. Electrical Distribution Equipment: Including, but not limited to, switchgear, switchboards, and panel boards.
   b. Motor Controllers.
   c. Air-Conditioning and Refrigerating Equipment Controllers.
4. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
5. Notify Engineer, in writing, of any existing circuit protective devices improperly rated for the calculated available fault current.

3.04 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.

b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse-current rating and type.

e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.

b. Voltage and current ratio for curves.

c. Three-phase and single-phase damage points for each transformer.

d. No damage, melting, and clearing curves for fuses.

e. Cable damage curves.

f. Transformer inrush points.

g. Maximum fault-current cutoff point.

h. Motor starting characteristics, damage points and overload relay.

i. Thermal damage curve for motors larger than 100 HP.

F. Completed data sheets for setting of overcurrent protective devices.

G. Complete Schedule of breaker settings to summarize information contained on data sheets. Sample schedule has been included at the end of this section for preferred format.

3.05 ARC FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system where work could be performed on energized parts including, but not limited to, the following:

1. Disconnect switches.

2. Electrical switchgear and switchboards.

3. Enclosed circuit breakers.

4. Motor starter.

5. Panelboards.

6. Transformers.

C. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent protection relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

D. Calculate the arc-flash protection boundary and the corresponding incident energy calculations for multiple system scenarios to be compared and the greatest incident energy to be uniquely reported for each equipment location. Calculations to be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions.

1. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off).

2. The maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. .

E. Incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors to be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

2. Fault contribution from synchronous motors should be decayed to match the actual decrement of each as closely as possible.

F. For each equipment location with a separately enclosed main device, calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

1. When performing incident energy calculations on the line side of a main breaker, the line side and load side contributions must be included in the fault calculation.

G. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device to compute the incident energy for the corresponding location.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash even, a maximum clearing time based on the specific location shall be utilized.

I. Complete Arc Flash report to be used for the preparation of Arc Flash Warning labels for electrical equipment. Refer to Division 26 Section “Identification for Electrical Systems” for requirements of Arc Flash Study and labels.

3.06 CORRECT DEFICIENCIES, RE-CALULCATE AND REPORT

A. After Engineer’s initial review, correct unsatisfactory conditions and recalculate to demonstrate compliance; resubmit overcurrent protective devices as required to bring system into compliance.

B. Revise and Resubmit report multiple times as necessary to demonstrate compliance with requirements.

3.07 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels as specified in Division 26 Section “Identification for Electrical Systems”. Install labels under the direct supervision and control of the Arc-Flash Hazard Study Specialist.

END OF SECTION 26 0573

SECTION 26 0800
COMMISSIONING OF ELECTRICAL

PART 1 - GENERAL

1.01 RELATED WORK

A. Division 22 - Plumbing

B. Division 23 - HVAC

1.02 REFERENCES

A. Drawings and general provisions of contract, including general and supplementary conditions, general mechanical provisions and Division-1 Specification sections, apply to work of this section.

B. ASHRAE Guideline 1-1996

C. ASHRAE Guideline 0-2005

D. ACG Commissioning Guideline – 2005

1.03 DESCRIPTION OF WORK

A. The purpose of the commissioning process is to provide the owner/operator of the facility with a high level of assurance that the mechanical systems have been installed in the prescribed manner, and operate within the performance guidelines set in the Basis of Design Documents (BOD). The CA shall provide the owner with an unbiased, objective view of the system's installation, operation, and performance. This process is not intended to take away or reduce the responsibility of the design team or installing contractors to provide a finished product. Commissioning is intended to enhance the quality of system start-up and aid in the orderly transfer of systems for beneficial use by the owner. The CA will be a member of the construction team, administrating and coordinating commissioning activities with the design team, construction manager, subcontractors, manufacturers and equipment suppliers.

B. The independent commissioning agent (CA) contracted directly with the owner for this project. This specification has been included for reference only to define contractors' responsibilities. Each contractor should review this procedure and include adequate time in their proposal.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 ROLES OF THE COMMISSIONING AGENCY

A. The primary point of responsibility is to inform the construction manager, the owner and design team on the status, integration, and performance of HVAC systems within the facility.

B. The CA shall function as a catalyst and initiator to disseminate information and assist the design and construction teams in implementing completion of the construction process. This shall include system verification, functional performance testing, and conformance with the intended design of each system. Services include documenting construction observations, verification and functional performance testing, and documenting proper distribution of performance and operating information to the owner's O&M staff.

C. Assist the responsible parties to maintain a high quality level of installation by meeting or exceeding prevailing standards and specifications.

D. The CA shall observe and coordinate testing as required to assure system performance meets the design intent.

E. The CA shall document the results of the performance testing directly and/or assure that the appropriate technicians document testing. The CA shall approve standard forms to be used by all parties for consistency of approach and type of information to be recorded.

F. The CA shall provide technical expertise to oversee and verify the correction of deficiencies found during the commissioning process.

G. The CA is to remain an independent party with specific knowledge of the project. The CA shall investigate the scope and extent of the problem and facilitate communication to determine responsibilities by delineating specifications. The CA shall monitor resolution for conformance with design intent and prevailing industry standards.

H. The CA shall document the date of acceptance as determined by the construction manager, owner and design team. System Verification Checklists and Functional Performance Test results may be used in determining the start of the warranty period for HVAC systems and subsystems.

I. The CA will review operating and maintenance materials for HVAC systems.

J. The CA will review phasing plans as provided by the CM relating to temporary use of HVAC equipment, O&M considerations, warranty issues, impact of construction sequencing on occupied areas, and interruption of services from the existing equipment.

3.02 SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS

A. Main Normal Distribution

B. Emergency Power System

C. Lighting Control Systems

D. Energy Metering System

3.03 ELECTRICAL COMMISSIONING PLAN

A. Commissioning Team

1. The Commissioning Team (CT) shall consist of key parties involved in design, construction and testing of this facility. It is necessary for each agency to appoint team members that will have long-term commitments to this project. Switching team members during the project will reduce the ability of the CT to provide continuity and acceptable results to the building owner. Team members must maintain an ongoing supervisory position on this project. One team member shall be provided by each of the parties listed below:

    a. Program Manager (PrM)
    b. Facilities Management Division (FMD)
    c. Commissioning Agent (CA)
    d. Design Team (DT)
    e. Construction Manager (CM)
    f. Mechanical Contractor (MC)
    g. Controls Contractor (CC)
    h. Test and Balance Contractor (TABC)
    i. Electrical Contractor (EC)

B. Basis of Design Document

1. The Basis of Design Document (BOD) represents a composite of design drawings, project specifications, submittals, change orders and industry standards that describe the systems of this facility. References to design intent will be taken from these contract documents. The BOD is an evolving manuscript maintained by the design professional to track and incorporate design alterations that occur throughout the construction process. Any industry standards used for this project will be specifically noted when referenced.
2. The CA will review the BOD documents for adequate commissioning provisions, functional performance, optimization of performance, accessibility, TAB provisions, and O&M considerations.

C. Commissioning Meetings

1. Commissioning meetings will be held in conjunction with progress meetings as necessary. Commissioning meetings will be used to address any problems that alter the

design intent or affect the commissioning process. These meetings provide an open forum for exchange of ideas between contractors, vendors, designers, users and owners.

D. Resolution Tracking Forms (RTF)

1. The use of Resolution Tracking Forms is a method employed by the CA to monitor and record problems, their causes, and solutions. The use of these lists promotes communication between the installing contractors, design team, commissioning agent, and owner, in order to expedite their resolution in a timely manner.
2. The CA will regularly submit RTF's to the CT in order to document and resolve deficiencies as quickly as possible. The frequency of RTF submission will be adjusted as project conditions dictate.

E. System Verification Checklists (SVC) / Manufacturers' Checklists

1. The MC/PC shall provide SVC's based on the manufacturers start-up procedures. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS. Draft copies will be submitted to the CT for review and comment prior to placement on the job site. A master copy of the SVC's will be bound in a three-ring binder and placed on the job site for use by the installing contractors. No system will be started until the appropriate SVC's have been completed.
2. The CA will review the SVC for each piece of equipment prior to start-up. Equipment will be released for start-up only after these checklists have been completed by the installing contractor and reviewed by the CA.
3. The equipment manufacturers' checklists must also be reviewed by the CA prior to start-up. These lists must be completed by the installing contractor, and reviewed by the CA before start-up can commence.

F. Start-Up

1. The appropriate contractors and/or manufacturer's representative will be required on site to perform start-up. No system will be started until the appropriate SVC's have been completed. No system will be started until the Manufacturer's checklists have been completed. Start-up will be performed according to the Manufacturer's recommended procedures. The CA will visit the site to review completeness of installation in conjunction with progress meetings prior to starting Plumbing equipment.
2. CT members involved in installation, fabrication, manufacture, control, or design of equipment are required to be present at the time of start-up. A factory-authorized technician will be on site to start equipment when required by the specifications. This will minimize delays in bringing equipment on line and expedite acceptable functional performance in accordance with the BoD.

G. Controls Monitoring

1. Close monitoring of the Control Contractor's progress will promote efficient coordination of the TAB work. The CC will be expected to submit point-to-point checklists verifying that his work has been completed and all systems are ready for TAB work and Functional Performance Testing. Programming and graphics will be surveyed by the CA for completeness and conformance with the BoD and the owner's scheduling requirements.

H. TAB Monitoring

1. The preliminary TAB report set-up will be reviewed prior to Electrical equipment start-up, in order to assure that the final TAB report format and content is acceptable.
2. TAB work will be monitored so that any problems that prevent or hinder proper air and water balance can be addressed and corrected with minimal delays. By addressing these problems as quickly as possible, we can assure that functional performance testing and owner training will take place on schedule.

3. A pencil copy of the TAB report will be reviewed prior to submission of the final TAB report. A written review will be submitted to the TAB contractor and to the DT for their comments. A TAB report approved by the DT will be required before Functional Performance Testing can be carried out. The CA will visit the site during the TAB process in order to assist TABC and CC in the effective completion of their scope of work.

I. Functional Performance Tests (FPT)

1. The CA will write FPT's based on the BoD. These tests will be created for systems and subsystems. See SYSTEMS INCLUDED IN THE COMMISSIONING PROCESS above.
2. Each major system will be tested. A random sample of each subsystem will be tested. This will be coordinated and witnessed by the CA and the owner's maintenance staff. Witnessing the FPT's will serve as a compliment to the O&M Training. No FPT's will be performed until the system and related subsystems have been started, the TAB report has been submitted and reviewed, and the completion of the control system has been documented through point-to-point checklists and other documentation.
3. The Functional Performance Tests shall include Electrical, Lighting and related equipment.

    a. The Electrical trade representative will demonstrate to the CxA: main power disconnect switch and feeder disconnect switches over current ground fault sensor trip settings by the primary injection method and in accordance with NETA-ATS Section 7.6, switchboard assemblies megger tested in accordance with NETA-ATS Section 7, switchboard metering instrumentation tests in accordance with NETA-ATS Sections 7.10 and 7.11, and switchboard single phase monitor tests for operation upon loss of a phase.
    b. The Electrical trade representative, with the CxA present, will field test for power operation for the emergency generator and transfer switches.
    c. Lighting controls will be tested under relevant operating conditions.
    d. A remote connection to energy metering system, energy dashboard, PV system, or any other system should be provided to the CA prior to system start-up for use as a tool to determine completion and accuracy of systems. CA in conjunction with the CT will ensure that all systems function properly through FPT's and through trend verification of systems.

4. Deferred Testing

    a. If tests cannot be completed because of a deficiency outside the scope of the responsible contractor, the deficiencies shall be documented and reported to the Owner. Deficiencies shall be resolved and corrected by the appropriate parties and test rescheduled.
    b. Off-season mode testing will be implemented as necessary to assure conformance with the BoD. Installing contractors will be expected to participate as required by the project specifications.

5. Rescheduled Functional Performance Test

    a. During Functional Performance Testing period, it is assumed that the contractors will be complete with all checklists when the commissioning agents travel to site. If the work is not ready for commissioning when the commissioning personnel are on site, their time will be billed at a rate of $1500.00 per day to the contractor as an additional fee.
    b. If the contractor has deficiencies that cannot be corrected at the time of the test, that part of the sequence will be retested at a later date. If the deficiency does not

pass during the retest, the contractor will be billed $1500.00 per day for the commissioning personnel's return trip.

J. Building Turn-Over / Owner Orientation / User Training

1. The CA will assist contractors prepare, coordinate and review O&M manuals, working closely with each contractor to achieve specificity and completeness.
2. The CA will review as-built drawings, working closely with each contractor to achieve specificity and completeness.
3. Owner training will be coordinated with the assistance of the CA. The training will be provided by the installing contractor, or manufacturer's representative. This training should include both classroom training and hands-on operational training. The owner may choose to videotape this training for future use. The CA will visit the site during the Turn-Over and Training period to assure that any on-going Electrical related problems are being addressed and corrected in a timely and efficient manner.
4. The CA will assist the owner/user with warranty issues.
5. The CA will assist in the coordination of off-season testing, calibrating, and servicing as specified in the contract documents.

3.04 RESPONSIBILITIES OF TEAM MEMBERS

A. Construction Manager (CM)

1. Include commissioning requirements in the mechanical, electrical, and controls contracts, as well as other subcontracts, to assure full cooperation of all parties in the Plumbing commissioning process.
2. Assure acceptable representation, with the means and authority to prepare and coordinate execution of the mechanical commissioning program as described in the contract documents.
3. Assure that the CA shall receive a copy of all construction documents, addenda, change orders and appropriate approved submittals and shop drawings for review and use in development of the commissioning plan.
4. Coordinate inclusion of commissioning activities in the construction schedule.
5. Facilitate resolution of deficiencies identified by observation or performance testing.
6. Assist the CA in monitoring the duct leakage testing.

B. Electrical Contractor (EC)

1. Include cost for commissioning requirements in the contract price.
2. Review design for provision of power to the Electrical equipment.
3. Attend commissioning meetings scheduled by the CA.
4. Verify proper installation and performance of all Electrical services provided.
5. Complete System Verification Checklists and manufacturer's pre-start checklists prior to scheduling startup of equipment.
6. Monitor and respond to Resolution Tracking Forms distributed by the CA in order to expedite corrective actions necessary to achieve design intent.
7. Provide an Electrical system technician to assist during verification and performance testing.
8. Participate in the Functional Performance Tests as required to achieve design intent.
9. Participate in the off-season mode testing as required to achieve design intent.
10. Participate in O&M Training as required by project specifications.

END OF SECTION 26 0800

SECTION 26 0923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Universal voltage power packs.
2. Room controllers.
3. Room controller wall stations.
4. Daylight sensors for room controllers
5. Indoor, low-voltage, ceiling-mounted occupancy sensors.
6. Indoor, low-voltage, wall-mounted occupancy sensors.
7. Low-voltage, momentary switches.
8. Switchbox mounted occupancy sensors.
9. Lighting contactors.
10. Emergency lighting control devices.

B. Related Requirements:

1. Division 26 Section "Wiring Devices" for manual light switches and wall plates.
2. Division 26 Section “Relay-Based Lighting Controls” for lighting relay control panels.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: These specifications and the accompanying Drawings define the intent of the lighting control system to be provided. The switches, sensors, control stations and switching group designations shown on the Drawings define how lighting should be grouped for control. Provide the necessary quantity and type of distributed control products necessary to achieve the design intent. In addition to the system as specified herein and shown on the Drawings, provide all planning, design, calculations, equipment, devices, cabling, system programming and any other component or service required for a complete, fully operational and code compliant system.

1.3 LIGHTING CONTROL APPLICATIONS

A. Minimum lighting control performance required, unless local Energy Code is more stringent:

1. Occupancy/Vacancy Requirements: Provide an occupancy/vacancy sensor with Manual On / Automatic Off or Automatic On / Automatic Off functionality in all spaces. Manual On vacancy sensors should be used for any enclosed space with a Manual On switch that does not require hands free operation. Spaces with multiple occupants or where line of sight might be obscured ceiling mount sensors and manual wallstations would be required. Automatic On of lighting via occupancy sensor cannot exceed 50% of lighting.
2. Daylight Zones: Primary side lit areas within an enclosed space shall be controlled separately and automatically by a multi-level photocontrol device without the need for programming.
3. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to dim electric light to the lowest light level.
4. Provide the ability to adjust the high end and low-end trim of the dimmers to ensure the lighting automatically provides energy saving even when daylighting calls for full illumination.
5. Provide the ability for the dimmers and the relays to function separately. Systems where the 0-10V dimmers and relays are tied together reduce design capabilities and shall not be acceptable.

B. Refer to the Lighting Controls Schedule in the Drawings for intended control sequences and equipment for each room.

1.4 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product.

1. Catalog sheets and specifications.
2. Ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements and installed features.
3. Storage and handling requirements and recommendations.
4. Installation instructions.

D. Shop Drawings: Wiring diagrams for the various components of the system specified including:

1. Composite wiring and/or schematic diagram of each control circuit, as proposed, to be installed.
2. Show location of all devices, including at minimum sensors, load controllers, and switches/dimmers for each area on Drawings.
3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer’s special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

1. Approved Shop Drawings and product data.
2. Sequence of Operation, identifying operation for each room or area.
3. Manufacturer’s maintenance information.
4. Detailed information on device programming and setup.
5. Startup and test reports.

B. Project Record Documents: Record actual installed locations and settings for lighting control devices.

C. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

D. Warranty: Copy of special warranty.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Occupancy Sensors: Provide one (1) of each product type for every 100 installed, to be used for maintenance.
2. Daylight Sensors: Provide one (1) of each product type for every 50 installed, to be used for maintenance.
3. Wallstations: Provide one (1) of each product type for every 100 installed, to be used for maintenance.

4. Room Controllers: Provide one (1) of each product type for every 100 installed, to be used for maintenance.
5. Power Packs: Provide one (1) of each product type for every 100 installed, to be used for maintenance.
6. Emergency Lighting Control Device: Provide one (1) for every 100 installed, to be used for maintenance.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of 10 years documented experience.

B. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

C. Retain "Testing Agency Qualifications" Paragraph below if Contractor is required to provide services of a qualified testing agency in "Field Quality Control" Article. Qualification requirements are in addition to those specified in Section 01 40 00 "Quality Requirements." See the Evaluations for discussion of NETA ATS and manufacturer's testing procedures.

D. All control wiring shall be in accordance to the NEC for class 2 remote control systems (Article 725).

E. The lighting control system shall comply with all IECC 2015 energy codes (at a minimum). If local or state energy codes exceed this requirement, those codes shall be the reference standard for compliance.

F. Comply with the latest edition of the NEC and all local/state codes as required.

G. Source Limitations: Obtain control systems from a single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packaging: All components of the lighting control system shall be packaged in a single box or as individual components. The catalog number will be marked on package label along with bill of materials. Individual component packages will be marked with product catalog number.

B. Handling: Packaging will include clear installation instructions for all components with typical illustrations of installation locations and connections. The installing contractor can easily match each package to the layout on the design floor plans.

C. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.10 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including but not limited to luminaires, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

1.11 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of lighting control devices that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Damage from transient voltage surges.
2. Warranty Period: Cost to repair or replace any parts for five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNIVERSAL VOLTAGE POWER PACKS

A. Manufacturer:

1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. General Requirements for Power Packs: Self-contained power supply relay system, plenum rated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Provide 24 VDC operating voltage to low-voltage occupancy sensors.
3. Integrates with low-voltage momentary switch to control any 24 VDC occupancy sensor.
4. Mounting: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
5. Indicator: LED indicator on device to indicate status of relay or if there is a low-voltage overcurrent.
6. Auto On or Manual On: Dip switch setting allows the user to select Auto On or Manual On as the operating mode.

2.2 ROOM CONTROLLERS

A. Manufacturer:

1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. The lighting control system using room controllers as defined under this Section covers the following equipment:

1. Room Controllers: Stand-alone one or two relay controller with 0-10V control for LED drivers with integral UL 924 emergency relay (model dependent), that smart devices connect to over a communications network.
2. Occupancy Sensors: Auto adjusting, NEMA WD7 compliant occupancy sensors.
3. Wallstations: Digital pushbutton wallstations and dimmers.
4. Scene Wallstation: Digital pushbutton scene wallstations, dimmers and programmable scene buttons.
5. Daylight Photosensor: Multi-zone open loop daylight sensor with two-way active infrared (IR) communications, which can provide dimming control for daylight harvesting and personal control and programming for the space.
6. Communication Network: Pre-defined lengths of communications cable (RJ45) for power and data to smart devices.

C. Room controllers for lighting zones automatically bind room loads to the connected control devices in the space without commissioning or the use of any tools. Provide controllers to match the room lighting control requirements. Control units include the following features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

2. Simple replacement using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf device.
3. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so that individual load numbers are assigned starting with load 1 to a maximum of 64, assigned based on each controller's device ID's from highest to lowest.
4. Device status LEDs to indicate:
   a. Data transmission.
   b. Device has power.
   c. Status for each load.
   d. Configuration status.
5. Installation features include:
   a. Standard junction box mounting.
   b. Quick low voltage connections using standard RJ-45 patch cable.
6. Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of utility power:
   a. Turn On to 100 percent.
   b. Turn Off.
   c. Turn On to last level.
7. Each load shall be configurable to operate in the following sequences based on occupancy:
   a. Auto On to 50% / Auto Off
   b. Manual On / Auto Off
8. All digital parameter data programmed into an individual room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
9. Dimming room controllers shall share the following features:
   a. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.
   b. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.
   c. The following dimming attributes may be changed or selected:
      1) Establish preset level for each load from 0-100 percent.
      2) Set high and low trim for each load.
   d. Override button for each load provides the following functions:
      1) Press and release for on/off control.
      2) Press and hold for dimming control.
   e. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.
   f. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100 percent dimming range defined by the minimum and maximum calibration trim.
   g. Calibration and trim levels must be set per output channel. Devices that set calibration or trim levels per controller (as opposed to per load) are not acceptable.

D. On/Off/0-10V Dimming Enhanced Room Controllers shall include:

1. One or two relay configurations.
2. Four (4) RJ-45 DLM local network ports. Provide integral strain relief.
3. One (1) dimming output per relay.
    a. 0-10V Dimming - Where indicated, one 0-10V analog output per relay for control of compatible LED drivers. The 0-10V output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.

2.3 ROOM CONTROLLER ZONE WALLSTATIONS

A. Low voltage momentary pushbutton switches in 1-, 2-, 3-, and 4-button configuration; compatible with wall plates with decorator opening. Wallstations shall include the following features:

1. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
2. Configuration LED on each switch that blinks to indicate data transmission.
3. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
4. Two RJ-45 ports for connection to the communications network.

B. Low voltage momentary pushbutton dimming switches in 1-button configuration; compatible with wall plates with decorator opening. Wallstations shall include the following features:

1. LED bar graph on side of device indicates relative light level of controlled load.
2. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
3. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
4. Configuration LED on each switch that blinks to indicate data transmission.
5. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
6. Two RJ-45 ports for connection to the communications network.

C. Multiple digital wallstations may be installed in a room by simply connecting them to the communications network. No additional configuration will be required to achieve multi-way switching.

2.4 DAYLIGHT SENSORS FOR ROOM CONTROLLERS

A. Digital daylighting sensors shall work with room controllers and relay panels to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to the controller or panel. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

B. Digital daylight sensors include the following features:

1. An internal photodiode that measures lightwaves within the visible spectrum and has a response curve that closely matches the photopic curve.
2. Sensor light level range shall be from 1-6,553 foot-candles (fc).

3. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
4. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
5. Configuration LED status light on device that blinks to indicate data transmission.
6. One RJ45 port for connection to room controller communications network.
7. Status LED indicates test mode, override mode and load binding.
8. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

2.5 INDOOR, LOW-VOLTAGE, CEILING-MOUNTED OCCUPANCY SENSORS

A. Manufacturer:
1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. General Requirements for Sensors: Ceiling-mounted, solid-state indoor occupancy sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
3. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Power Pack Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4. Indicator: LED indicator on sensor to show when motion is detected during testing and normal operation of sensor.
5. Automatic Light-Level Sensor: Adjustable from 10 to 300 fc; turn lights off when selected lighting level is present.
6. Manual On Function: Sensor shall have a manual on function that is facilitated by a low-voltage momentary switch.

C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 750 sq. ft. when mounted on a 96-inch- high ceiling.

D. Operation:

1. Occupancy Mode in Corridors: Turn lights on automatically at 100% when covered area is occupied and turn them off automatically when unoccupied.
2. Vacancy Mode in Storage Rooms: Turn lights on manually when covered area is occupied and turn them off automatically when unoccupied.
3. Time delay for turning lights off shall be adjustable over a minimum range of 5 to 30 minutes.

2.6 INDOOR, LOW-VOLTAGE, WALL-MOUNTED OCCUPANCY SENSORS

A. Manufacturer:

1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. General Requirements for Sensors: Wall-mounted, solid-state indoor occupancy sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
3. Mounting:
   a. Sensor: Swivel mounting bracket attached to sensor allows sensor to be angled for wall or ceiling mounting on a standard outlet box.
   b. Power Pack Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
4. Indicator: LED indicator on sensor to show when motion is detected during testing and normal operation of sensor.
5. Automatic Light-Level Sensor: Adjustable from 10 to 200 fc; turn lights off when selected lighting level is present.

C. Dual-Technology Type: Wall-mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detection Coverage (Standard Room): Detect walking motion occupancy anywhere within a circular area of 2000 sq. ft. and desktop motion within a circular area of 1000 sq. ft. when mounted at 10-foot above floor.

D. Operation:

1. Occupancy Mode in Corridors: Turn lights on automatically at 100% when covered area is occupied and turn them off automatically when unoccupied.
2. Time delay for turning lights off shall be adjustable over a minimum range of 5 to 30 minutes.

2.7 LOW-VOLTAGE, MOMENTARY SWITCHES

A. Manufacturer:

1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. General Description:

1. Decorator styling compatible with screwless or standard wall plates.
2. Internal green LED which can function as either a locator or pilot light, depending upon application and how the switch is wired.
3. When top of switch is pressed, an internal contact between an on and common terminal is made; when bottom of switch is pressed, an internal contact between an off and common terminal is made.

C. Wall Plate: Comply with wall plate requirements in Division 26 Section "Wiring Devices".

D. Finish: Comply with finishes requirements in Division 26 Section "Wiring Devices".

2.8 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturer:

1. Subject to compliance with requirements, provide one of the products indicated on Lighting Controls Schedule. Refer to Lighting Controls Schedule for manufacturers and model numbers.
2. Manufacturer's catalog numbers together with the descriptions and sequences on the Drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

B. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual technology.

1. Connections: Hard wired, line-voltage.
2. Rated 1200 W at 277 VAC for LED lighting, and ¼ hp at 120 VAC.
3. Adjustable time delay of 15 minutes.
4. Able to be locked to Manual-On mode.
5. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc
6. Comply with NEMA WD 1, UL 20, and FS W-S-896.

C. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.

D. Finishes, including device color, wall plate and lettering: Comply with Division 26 Section "Wiring Devices."

E. Wall Plates: Comply with wall plate requirements in Division 26 Section "Wiring Devices."

2.9 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB/General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation.
4. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and mechanically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.
2. Control: On-off operation based on BAS time schedule.

2.10 EMERGENCY LIGHTING CONTROL DEVICES

A. Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz., 20 amp ballast rating.
2. Push to test button.
3. Auxiliary contact for remote test or fire alarm system interface

2.11 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

C. Switchbox mounted sensors:

1. Set field selectable sensors to automatic “on” automatic “off” for all devices indicated to be Occupancy sensors on the Drawings. Set all other sensors to field selectable manual “on”.
2. Comply with installation and connection requirements in Division 26 Section “Wiring Devices.”

3.2 EQUIPMENT INSTALLATION

A. The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits.

B. Install all room/area devices using manufacturer's communications cable with pre-terminated RJ-45 connectors.
1. Low voltage wiring topology must comply with manufacturer's specifications.
2. Route network wiring as indicated on the Drawings as closely as possible. Document final wiring location, routing and topology on as built drawings.

C. Install the work of this Section in accordance with manufacturer’s printed instructions unless otherwise indicated.

D. All line voltage connections shall be tagged to indicate circuit and switched legs.

E. Test all devices to ensure proper communication.

F. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings. Adjust time delay so that controlled area remains lighted while occupied.

G. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
1. Sensor parameters, time delays, sensitivities and daylighting setpoints.
2. Sequence of operation.
3. Load parameters.

3.3 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. General requirements:
1. All cabling shall be plenum rated cable for all plenum areas.
2. It is permissible to install cabling exposed (without conduit) in areas above lay-in ceilings. All other low voltage cabling shall be installed in conduit. This includes but is not limited to mechanical rooms, areas without lay-in style ceilings, areas with hard (non-removable) ceilings, etc.
3. All cabling installed exposed shall be installed in J-hooks. It is not acceptable to “tie-wrap” cables to structural building members, install cables unsupported, or to install cable through structural members as a means of support. Cables shall also be installed in a

neat and orderly manner. Cable shall be installed at angles parallel or perpendicular to structural members. Diagonal or “shortest path” installations of cable is not acceptable.

4. Conduits ends shall include bushings for protection of the cable(s) entering or leaving the conduit when transitioning from areas requiring installation in conduit to areas that do not require conduit installation.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label contactors with a unique designation.

C. Provide self-adhesive label on ceiling or ceiling grid below each local room controller or power pack to identify the specific module mounted above ceiling. Provide unique naming convention for each local room controller or power pack. Provide same label to room controller or power pack itself.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections according to manufacturer’s start-up procedures.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.8 PRODUCT SUPPORT AND SERVICE

A. Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

3.9 COMMISSIONING

A. Upon completion of the installation, the system shall be commissioned by both the manufacturer's factory authorized representative who will verify a complete fully functional system as well as the Project’s Commissioning Agent.

B. The electrical contractor shall provide both the manufacturer and the electrical engineer with twenty-one working days written notice of the system startup and adjustment date.

C. Upon completion of the system commissioning, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.10 ADJUSTING

A. Time-Schedule Adjustments: Times indicated in documents represent initial settings known at time of design documentation. Coordinate final program settings for time-of-day and holiday schedules with Owner prior to Substantial Completion. When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjust schedules to suit Owner. Provide up to one visit to Project during other-than-normal occupancy hours for this purpose.

B. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.11 CLEANING

A. Clean components according to manufacturer's written instructions.

B. On completion of device box installation but before any wiring devices are installed, inspect interior of boxes and perform the following:

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of wall plate installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Replace cracked or damaged wall plates.
3. Wipe down all wall plates with approve cleaning agent to remove fingerprints and dust.

3.12 DEMONSTRATION

A. Upon completion of the system commissioning, the factory-authorized technician shall provide the proper training to the Owner's personnel on the adjustment and maintenance of the system.

B. Provide a minimum of four (4) hours training on the operation and maintenance of the lighting systems room controls, at job site. Provide programming training as required to allow the Owner to do any programming that the supplier is allowed to do during commissioning, testing, service and field additions or deletions to the system. Illustrate utilization of all components and the interaction of the complete system. Provide this training at no cost to the Owner, including transportation, lodging, meals and training manuals. Video tape each training session and provide copy to Owner.

END OF SECTION 26 0923

SECTION 26 09 43.23
RELAY-BASED LIGHTING CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Networked lighting control panels using control-voltage relays for switching.

1.02 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital control.

C. IP: Internet protocol.

D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Operational documentation for software and firmware.

D. Shop Drawings: For each relay panel and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail wiring partition configuration, current, and voltage ratings.

4. Short-circuit current rating of relays.

5. Address Drawing: Reflected ceiling plan and floor plans, showing connected luminaires, address for each luminaire, and luminaire groups. Base plans on construction plans, using the same legend, symbols, and schedules.

6. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

7. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

C. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

D. Sample Warranty: For manufacturer's special warranty.

1.05 CLOSEOUT SUBMITTALS

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

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB drive.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.

C. Warranty: Copy of warranty.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lighting Control Relays: Equal to five (5) percent of amount installed for each size indicated, but no fewer than two (2).

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing of centralized and distributed lighting control systems with a minimum of ten (10) years documented experience.

B. Installer Qualifications: Company certified by the manufacturer and specializing in installation of networked lighting control products with minimum three (3) years documented experience.

C. System Components: Demonstrate that individual components have undergone quality control and testing prior to shipping.

D. All control wiring shall be in accordance to the NEC for class 2 remote control systems (Article 725).

E. The lighting control system shall comply with all IECC 2015 energy codes (at a minimum). If local or state energy codes exceed this requirement, those codes shall be the reference standard for compliance.

F. Comply with the latest edition of the NEC and all local/state codes as required.

G. Source Limitations: Obtain control systems from a single manufacturer.

H. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panels for installation according to NECA 407.

B. Store products in a clean, dry space in original manufacturer’s packaging in accordance with manufacturer’s written instructions until ready for installation.

1.09 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 32° to 104° F.

2. Relative Humidity: Maximum 90 percent, non-condensing.

C. Coordinate layout and installation of luminaires and controls with other construction.

D. Coordinate site commissioning with manufacturer no less than 21 days prior to required date.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of standalone multi-preset modular dimming controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for two (2) years from date of Substantial Completion.

3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight (8) years, that failed in service due to transient voltage surges.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control panels. Any combination of inputs shall be programmable to any number of control relays.

B. Surge Protective Device: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

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 47 CFR 15, Subparts A and B, for Class A digital devices.

E. Comply with UL 916.

2.02 NETWORKED LIGHTING CONTROL PANELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation; Cooper Greengate Lighting.

2. Lithonia Lighting; Acuity Brands Lighting, Inc.

3. Leviton Mfg. Company, Inc.

4. Lutron Electronics Co., Inc.

B. Description: Lighting control panels using mechanically latched relays to control lighting and appliances. The panels shall be capable of being interconnected with digital communications to appear to the operator as a single lighting control system.

C. Lighting Control Panels:

1. A single enclosure with incoming lighting branch circuits, control circuits, switching relays, and on-board timing and control unit.

2. A vertical barrier separating branch circuits from control wiring.

D. Main Control Unit: Installed in the main lighting control panel only; powered from the branch circuit of the standard control unit.

1. Ethernet Communications: Comply with TCP/IP protocol. The main control unit shall provide for programming of all control functions of the main and all networked slave lighting control panels including timing, sequencing, and overriding.

2. Web Server: Display information listed below over a standard Web-enabled server for displaying information over a standard browser.
    a. A secure, password-protected login screen for modifying operational parameters, accessible to authorized users via Web page interface.
    b. Panel summary showing the master and slave panels connected to the controller.
    c. Controller diagnostic information.
    d. Show front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. These mimic screens shall also allow direct breaker control and zone overrides.
3. Timing Unit:
    a. 365-day calendar, astronomical clock, and automatic adjustments for daylight savings and leap year.
    b. Clock configurable for 12-hour (A.M./P.M.) or 24-hour format.
    c. Four independent schedules, each having 24 time periods.
    d. Schedule periods settable to the minute.
    e. Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
    f. 16 special date periods.
4. Time Synchronization: The timing unit shall be updated not less than every six (6) hours with the network time server.
5. Sequencing Control with Override:
    a. Automatic sequenced on and off switching of selected relays at times set at the timing unit, allowing timed overrides from external switches.
    b. Sequencing control shall operate relays one at a time, completing the operation of all connected relays in not more than 10 seconds.
    c. Override control shall allow any relay connected to it to be switched on or off by a field-deployed manual switch or by an automatic switch, such as an occupancy sensor.
    d. Override control "blinking warning" shall warn occupants approximately ten (10) minutes before actuating the off sequence.
    e. Activity log, storing previous relay operation, including the time and cause of the change of status.
    f. Download firmware to the latest version offered by manufacturer.

E. Standard Control Unit, Installed in All Lighting Control Panels: Contain electronic controls for programming the operation of the relays in the control panel, contain the status of relays, and contain communications link to enable the digital functions of the main control unit. Comply with UL 916.
1. Electronic control for operating and monitoring individual relays, and display relay on-time.
2. Nonvolatile memory shall retain all setup configurations. After a power failure, the controller shall automatically reboot and return to normal system operation.
3. Integral keypad and digital-display front panel for local setup, including the following:
    a. Blink notice, time adjustable from software.
    b. Ability to log and display relay on-time.
    c. Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.

F. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 120-V tungsten, 30 A at 277-V ballast, 1.5 hp at 120 V, and 3 hp at 277 V. Short-circuit current rating shall be not less than 14 kA. Control shall be digital control network.

G. Power Supply: NFPA 70, Class 2, UL listed, sized for connected equipment, plus not less than 20 percent spare capacity. Powered from a dedicated branch circuit of the panelboard that supplies power to the line side of the relays, sized to provide control power for the local panel-mounted relays, bus system, low-voltage inputs, field-installed occupancy sensors, and low-voltage photo sensors.

H. Operator Interface: At the main control unit, provide interface for a tethered connection of a portable PC running MS Windows for configuring all networked lighting control panels using setup software designed for the specified operating system. Include one portable device for initial programming of the system and training of Owner's personnel. That device shall remain the property of Owner.

I. Software:

1. Menu-driven data entry.
2. Online and offline programming and editing.
3. Provide for entry of the room or space designation for the load side of each relay.
4. Monitor and control all relays, showing actual relay state and the name of the automatic actuating control, if any.
5. Size the software appropriate to the system.

2.03 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, momentary contact, three wire, for operating one or more relays and to override automatic controls.

1. Match color and style specified in Division 26 Section "Wiring Devices."
2. Integral green LED pilot light to indicate when circuit is on.
3. Internal white LED locator light to illuminate when circuit is off.

B. Key-Operated Switches: Low voltage, momentary contact switch with factory-supplied A126 key in lieu of switch handle. The A126 key shall be pinned to match district standard keying throughout the district.

C. Wall Plates: Single and multi-gang plates as specified in Division 26 Section "Wiring Devices."

2.04 FIELD-MOUNTED SIGNAL SOURCES

A. Daylight Harvesting Switching Controls: Comply with Division 26 Section "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

B. Indoor Occupancy Sensors: Comply with Division 26 Section "Lighting Control Devices." Control power may be taken from the lighting control panel, and signal shall be compatible with the relays.

2.05 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 22 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

D. Twisted-Pair Data Cable: Category 6. Comply with requirements in Division 27 Section "Communications Copper Horizontal Cabling."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panels according to NECA 407.

B. Examine panels before installation. Reject panels that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panels for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental airspaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceways and Boxes for Electrical Systems."

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.

3.03 PANEL INSTALLATION

A. Comply with NECA 1.

B. Install panels and accessories according to NECA 407.

C. Mount top of trim 90 inches above finished floor unless otherwise indicated.

D. Mount panel cabinet plumb and rigid without distortion of box.

E. Install filler plates in unused spaces.

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

C. Create a directory to indicate loads served by each relay; incorporate Owner's final room designations. Obtain approval before installing. Use a PC or typewriter to create directory; handwritten directories are unacceptable.

D. Lighting Control Panel Nameplates: Label each panel with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers described below and low-voltage surge arrestors. Certify compliance with manufacturer's test parameters.

a. Circuit-Breaker Tests:
   1) Compare nameplate with Drawings and Specifications.
   2) Inspect physical and mechanical conditions.
   3) Inspect anchorage and alignment.
   4) Verify that the units are clean.
   5) Operate the circuit breaker to ensure smooth operation.
   6) Inspect bolted electrical connections for high resistance using one or more of the following methods:
      a) A low-resistance ohmmeter.
      b) Verify tightness of bolted electrical connections by calibrated torque wrench.
      c) Thermographic survey.
   7) Inspect operating mechanism, contacts, and arc chutes in unsealed units.
   8) Perform adjustments for final protective device settings according to the overcurrent protective device coordination study. Comply with requirements in Division 26 Section "Overcurrent Protective Device Studies."
   9) Perform insulation resistance tests for one minute on each pole, phase-to-phase, and phase-to-ground with the circuit breaker closed and across each pole using manufacturer's published data.
   10) Perform a contact/pole-resistance test.
   11) Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be for one minute. Follow manufacturer's written instructions for solid-state units.
   12) Determine long-time pickup and delay by primary current injection.
   13) Determine short-time pickup and delay by primary current injection.
   14) Determine ground-fault pickup and time delay by primary current injection.
   15) Determine instantaneous pickup by primary current injection.
   16) Test functions of the trip unit by means of secondary injection.
   17) Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data.
   18) Verify correct operation of auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function, and trip unit battery condition. Reset trip logs and indicators.
   19) Verify operation of charging mechanism.
b. Surge Arrestor Tests:
   1) Compare nameplate with the Contract Documents.
   2) Inspect physical and mechanical conditions.
   3) Inspect anchorage, alignment, grounding, and clearances.
   4) Verify that the units are clean.
   5) Inspect bolted electrical connections for high resistance using one or more of the following methods:
      a) Low-resistance ohmmeter.
      b) Verify tightness of bolted electrical connections by calibrated torque wrench.

6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

7) Perform an insulation-resistance test on each arrestor, phase terminal-to-ground using voltage according to manufacturer written instructions.

8) Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding tests.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Lighting control panel will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies lighting control panels and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

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

2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

3.07 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, 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.

3.08 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years 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.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following types of high efficiency, dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

1. Include typical manufacturer’s test data reports for each type and size transformer. Reports shall include but not be limited to the following data:

a. Efficiency in accordance with DOE 2016 Efficiency.

b. Efficiency at 35-percent, 50-percent and 100-percent load.

c. Percent voltage regulation at 80-percent and 100-percent power factor.

d. Losses in kVA at no load and full load conditions.

e. Percent X and Percent R values,

f. Maximum sound level of transformer in enclosure (in dBA).

g. Maximum 30-Deg hot spot and average temperature rise over a 40-degree C ambient.

D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

E. Warranty: Copy of special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Source quality-control test reports.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

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

B. Warranty: Copy of warranty.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

E. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.07 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transformers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Twenty-five (25) year pro-rated warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mirus International, Inc.

2. Power Quality International.

3. Powersmiths International Corp.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. 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.

C. Transformers Rated 15 kVA and Larger:

1. Exceed 10 CFR 431 (DOE 2016) efficiency levels by 20 percent minimum.

2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging, silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below saturation to allow for a minimum of 10% over voltage excitation. The cores shall be clamped with structural angles (formed angles not acceptable) and bolted to the enclosure to prevent damage during shipment or rough handling.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure; the core and coils shall be visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.
4. Vacuum impregnated with non-hygroscopic, thermosetting varnish.
5. Each layer shall have end fillers or tie downs to provide maximum mechanical strength.
6. Materials incorporated must have at least a minimum of one year of proven field usage. Accelerated laboratory tests not acceptable in lieu of this field usage.
7. Provide final wrap of electrical insulating material to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable.

D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

E. Enclosure for Interior Transformers: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
2. Core and coil unit shall be completely isolated from the enclosure by means of a vibration isolating system and shall be so designed as to provide for continual securement of the core and coil unit to the enclosure.
3. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
4. Wiring Compartment: Sized for conduit entry and wiring installation.

F. Transformer Enclosure Finish: Comply with NEMA 250. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of a polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces.

1. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 14 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 130 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 130 deg C rise above 40 deg C ambient temperature.

L. The maximum top of case temperature shall not exceed 35 deg C above ambient.

M. Grounding: Provide ground bar kit or a ground bar installed on the inside of the transformer enclosure.

N. K-Factor Rating: Transformers shall be K-13 rated and shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Construct K-rated transformers in accordance with requirements of Distribution Transformers listed above, unless otherwise indicated.
4. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP2 with a K-factor equal to one.

O. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

P. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

Q. Impedance: Between 3.5% and 5.8% unless otherwise noted.

R. Zero Sequence Impedance/Reactance: Less than 0.95% and 0.3% respectively.

S. Wall Brackets: Manufacturer's standard brackets.

T. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:

1. 9 kVA and Less: 40 dBA
2. 10 to 45 kVA: 42 dBA
3. 46 to 150 kVA: 45 dBA
4. 151 to 300 kVA: 50 dBA
5. 301 to 500 kVA: 54 dBA
6. 501 to 750 kVA: 57 dBA
7. 751 to 1000 kVA: 59 dBA

2.04 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.

7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:
   a. High-voltage to ground.
   b. Low-voltage to ground.
   c. High-voltage to low-voltage.
9. Temperature tests.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Transformer Mounting
   1. 15 kVA or less: Floor mounted or suspended, as indicated.
   2. 30 kVA and 45kVA: floor mounted, rack mounted or suspended, as indicated.
   3. 75 kVA: Floor mounted or rack mounted, as indicated.
   4. Greater than 75 kVA: Floor mounted or rack mounted, unless otherwise indicated.

3.03 INSTALLATION

A. Comply with NECA 409, “Recommended Practice for Installing and Maintaining Dry-Type Transformers” as published by the National Electrical Contractors Association.

B. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

C. Install transformer level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

D. Construct concrete bases and anchor floor-mounting transformers level on concrete bases, 4-inch nominal thickness according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems." Concrete materials and installation requirements are specified in Division 3.

E. Construction steel channel support system for rack-mounted or suspended transformers according to manufacturer’s written instruction and requirements of Division 26 Section “Hangers and Supports for Electrical Systems.”

F. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

G. Remove shipping bolts, blocking, and wedges.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Transformer Nameplates: Label each transformer with Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

3.05 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible metal conduit with a minimum 12-inch to a maximum 24-inch length for wiring connections to transformer enclosure.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.07 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.08 CLEANING

A. Clean components according to manufacturer's written instructions.

B. On completion of installation, inspect interior and exterior surfaces and perform the following:

1. Remove paint splatters and other spots.

2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3. Repair exposed surfaces to match original finish.

3.09 PROTECTION

A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Apply temporary heating as required.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2200

SECTION 26 2413
SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Related Sections include the following:

1. Division 26 Section "Overcurrent Protective Device Studies" for short-circuit rating of devices and for setting of overcurrent protective devices.
2. Division 26 Section "SPD for Low-Voltage Electrical Power Circuits" for internal surge protective devices.

1.02 DEFINITIONS

A. DPM: Multifunction Digital-Metering Monitor

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. GFEP: Ground-fault equipment protection.

E. RFI: Radio-frequency interference.

F. RMS: Root mean square.

G. SCADA: Supervisory Control And Data Acquisition.

H. SPDT: Single pole, double throw.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Switchboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated, include the following:

1. Manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Rated capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
    a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.
3. Hardcopy layout of each display screen in HMI and DPM.
4. Power Monitoring Block Diagram: Show devices monitored and interconnections between components specified in this Section. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Illustrate coordination among related equipment and power monitoring and control.

E. Shop Drawings: For each switchboard and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
    a. Tabulation of installed devices with equipment features and ratings.
    b. Enclosure types and details for types other than NEMA 250, Type 1.
    c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    e. One-line diagram.
    f. Horizontal and vertical bus current and voltage ratings.

g. Short-time and short-circuit current rating of switchboards and overcurrent protective devices.

h. Feeder entry locations and lug configuration.

i. Floor plan drawing showing locations for anchor bolts.

j. Nameplate legends.

k. Descriptive documentation of optional barriers specified for electrical insulation and isolation.

l. Evidence of NRTL listing for series rating of installed devices.

m. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

n. Schematic and wiring diagrams for power, signal, and control wiring.

2. Wiring Diagrams: For each type of switchboard and related equipment, include the following:

a. Power, signal, and control wiring.

b. Three-line diagrams of current and future secondary circuits showing device terminal numbers and internal diagrams.

c. Schematic control diagrams.

d. Diagrams showing connections of component devices and equipment.

e. Schematic diagrams showing connections to remote devices.

F. Warranty: Copy of special warranty specified in this Section.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field Quality-Control Reports:

1. Test procedures used.

2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

4. Manufacturer’s sample system checklists and log sheets.

B. Warranty: Copy of warranty.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. 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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

C. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

D. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

E. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

F. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

G. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.09 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F.

b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB (General Electric Company); Industrial Connection & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

2.02 RATINGS

A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.

B. Nominal System Voltage: As indicated on the Drawings.

C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.

D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in switchboard assembly.

1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

2.03 MANUFACTURED UNIT FABRICATION

A. Factory assembled and tested and complying with UL 891; including devices complying with UL 489.

B. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.

C. Front-Connected, Front-Accessible Switchboards: Front and Rear aligned, with features as follows:
   1. Main and Tie Devices: Fixed, individually mounted, insulated case circuit breakers.
   2. Feeder Devices: Panel mounted, thermal-magnetic circuit breakers.
      a. Provide electronic trip-unit circuit breakers for feeders serving Emergency Systems or Legally Required Standby Systems.

D. Indoor Enclosure Fabrication: Steel, rated for environmental conditions at installed location.
   1. Indoor Location Rating: NEMA 250, Type 1.
   2. Wet or Damp Indoor Location Rating: NEMA 250, Type 4.
   3. Finish: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.
   4. Hinged Front Panels: Allow access to metering, accessory, and blank compartments. Hinged panels must be arranged for minimum of 120-degree swing; standard 90-degrees swing is not acceptable.
   5. Access: Removable, Hinged Front and Compartment Covers secured by captive bolts for access to interior of switchboard.

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Insulation and isolation for main and vertical buses of feeder sections.

H. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
   2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated, with copper feeder circuit-breaker line connections.
   3. Ground Bus: 1/4-by-2-inch-, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   5. Disconnect Links:
      a. Isolate neutral bus from incoming neutral conductors.
      b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

6. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

N. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, internally mounted in its own compartment, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the switchboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

O. Phase Loss Protection: Provide a phase failure relay on main circuit breaker complete with capacitor trip device and shunt trip. Relay shall be able to be bypassed at any time. All devices shall be factory installed.

1. Manufacturer: Taylor Electronics, Inc. Phase-Guard PND Model or Owner-approved equal.
2. Provide the following options and accessories on the phase failure relay:
   a. Adjustable phase unbalance from 5 to 15 percent.
   b. Adjustable time delay from 0.5 to 20 seconds.
   c. Remote display module mounted to the front of the main section of the switchboard with USB connection for computer.
   d. Relay shall not trip on total power loss.

P. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200A or higher, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Enclosed, Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Standard-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
   a. Instantaneous trip.
   b. Long- and short-time time adjustments with I2t response.
   c. Long- and short-time pickup levels.
   d. Ground-fault pickup level, time delay, and I2t response.
4. Remote trip indication and control.
5. Insulated-Case Circuit-Breaker (ICCB) Features and Accessories:
   a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material; UL 486B listed, dual rated and marked for use with copper or aluminum load-side conductors.
   b. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   c. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function and short-time function.

d. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

e. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

f. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

g. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement mechanism, including draw out mechanism.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.

b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material; UL 486B listed, dual rated and marked for use with copper or aluminum load-side conductors.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function and short-time function.

e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.

f. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement mechanism.

2.05 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; [wound] [bushing] [bar or window] type; [single] [double] secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

2. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Electro Industries/GaugeTech Shark 100 meter.

2. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Megawatts: Plus or minus 2 percent.

e. Megavars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.

i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

j. Contact devices to operate remote impulse-totalizing demand meter.

3. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.

4. Meter shall have 10/100BaseT Ethernet with Modbus TCP protocol capabilities to interface with building automation controls system. Coordinate with controls system manufacturer for exact connection type and requirements.

2.06 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.07 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.08 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.

2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.

3. Protect from moisture, dust, dirt, and debris during storage and installation.

4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Examine rough-in of conduits to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

E. Verify that ground connections are in place and that requirements in Division 26 Section “Grounding and Bonding for Electrical Systems” have been met.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components once unit is secured in place.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

H. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.

I. Comply with NECA 1.

3.03 CONNECTIONS

A. Tighten bus joints, electrical connectors, and terminals according to manufacturer’s published torque-tightening values.

B. Ground equipment according to Division 26 Section “Grounding and Bonding for Electrical Systems.”

C. Connect wiring according to Division 26 Section “Low-Voltage Electrical Power Conductors and Cables.”

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Perform factory start-up of switchboard.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:
        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Studies."

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. Prior to installation of front trim and cover plates, inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.

2. Remove all temporary markings and labels.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

3.09 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 2413

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

B. Related Sections include the following:

1. Division 26 Section “Overcurrent Protective Device Studies” for short-circuit rating of devices and for setting of overcurrent protective devices.
2. Division 26 Section “SPD for Low-Voltage Electrical Power Circuits” for surge protective devices.

1.02 DEFINITIONS

A. DPM: Multi-function Digital-Metering Monitor.

B. EMI: Electromagnetic Interference.

C. GFCI: Ground-fault circuit interrupter.

D. GFEP: Ground-fault equipment protection.

E. MCCB: Molded-case circuit breaker.

F. RFI: Radio-frequency interference.

G. RMS: Root mean square.

H. SPD: Surge protective device.

I. SPDT: Single pole, double throw.

J. SVR: Suppressed voltage rating.

K. VPR: Voltage protection rating.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Panelboard Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of panelboard, switching and overcurrent protective device, accessory, and related component, include the following:

1. Manufacturer’s dimensions and technical data on features, performance, electrical characteristics, ratings, and finishes.
2. Related capacities, features, operating characteristics, furnished specialties, factory settings, accessories and time-current characteristic curves for individual relays and overcurrent protective devices.
    a. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc. Indicate available setting points and selectable ranges for each type of adjustable overcurrent protection device.

E. Shop Drawings: For each panelboard and related equipment, include the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show method of field assembly and location and size of each field connection. Include the following:
    a. Tabulation of installed devices, equipment features, and ratings.
    b. Enclosure types and details for types other than NEMA 250, Type 1.
    c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
    d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
    e. Bus current and voltage ratings.
    f. One-line diagram.
    g. Short-circuit current rating of panelboards and overcurrent protective devices.
    h. Feeder entry locations and lug configuration.
    i. Elevation drawing showing locations for anchor bolts.
    j. Nameplate legends.
2. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
3. Wiring diagrams: For each type of panelboard and related equipment, include power, signal, and control wiring.

F. Warranty: Copy of special warranty specified in this Section.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Manufacturer’s routine maintenance requirements for panelboard and all installed components.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
4. Manufacturer’s sample system checklists and log sheets.

B. Warranty: Copy of warranty.

1.07 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer, unless otherwise indicated.

1. Breaker Manufacturer: Manufacturer for breakers shall be the same as the manufacturer of other breakers proposed for other portions of the Work.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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 NEMA PB 1.

E. Comply with NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

C. Handle equipment components according to manufacturer’s written instructions. Use factory-installed lifting provisions.

D. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

E. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

F. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.09 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace panelboard devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cutler-Hammer, Inc.; Eaton Corporation.

2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; Schneider Electric.

2.02 RATINGS

A. Suitable for application in 3-phase, 60-Hz, solidly grounded-neutral system, unless otherwise indicated.

B. Nominal System Voltage: As indicated on the Drawings.

C. Main-Bus: Amperage as indicated on the Drawings. Provide continuous rating across entire length of main-bus.

D. Short-Time and Short-Circuit Current: Match rating of highest-rated overcurrent protective device in panelboard assembly.

1. Available Short-Circuit Current: As indicated on the Drawings. Refer to Division 26 Section "Overcurrent Protective Device Coordination Study" for additional requirements.

2.03 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Mounting height of breakers shall be in accordance with NFPA 70 requirements. Fabrication of equipment shall take housekeeping pad dimension into account in determining height of top breaker in all sections. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for housekeeping pad specifications.

B. Enclosures: Surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

b. Outdoor Locations: NEMA 250, Type 3R.

c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84-inches maximum.

3. Front Cover: Provide the following, unless otherwise indicated:

a. Hinged Front Cover: Door-in-Door construction with entire front trim hinged to box and with standard door within hinged trim cover to access device handles.

4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Top and bottom.

D. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.

b. Bus shall be fully rated the entire length.

2. Panelboard interior assembly shall be dead front with panelboard front removed. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

5. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards served from K-rated transformers. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.

E. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: Ten percent.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50 deg C rise above ambient. Heat rise tests shall be conducted in accordance with UL 67. The use of conductor dimensions will not be accepted in lieu of actual heat tests.

2.04 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 48 inches high, provide two latches, keyed alike.

C. Main Overcurrent Protection Device Type: Circuit breaker.
1. Main OCPD rated less than 250 Amps: Thermal-Magnetic Circuit Breakers.
2. Main OCPD rated 250 Amps and greater: Electronic Trip-Unit Circuit Breakers.
3. Main OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

D. Feeder Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
1. Feeder OCPD rated less than 250 Amps: Thermal-Magnetic; Bolt-on circuit breakers.
2. Feeder OCPD rated 250 Amps and greater: Thermal-Magnetic**;** Bolt-on circuit breakers or plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Feeder OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

E. Branch Overcurrent Protection Device Type: Provide overcurrent device as follows, unless otherwise indicated: Circuit breaker.
1. Branch OCPD rated less than 125 Amps: Bolt-on Thermal-Magnetic circuit breakers.
2. Branch OCPD rated 125 Amps and Greater: Bolt-on Thermal-Magnetic circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent,

individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between “ON” and “OFF”. Provisions for additional breakers shall be such that no additional connectors will be required to add breakers.

G. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, externally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

2.05 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type. Panelboards shall be of the dead-front, quick-make, quick-break, bolt-on circuit breaker type.

B. Main Overcurrent Protection Device Type: Circuit breaker or lugs only.

1. Main OCPD rated less than 250 Amps: Thermal-Magnetic Circuit Breakers.
2. Main OCPD rated 250 Amps and Greater: Thermal-Magnetic Circuit Breakers.
3. Main OCPD for Emergency Systems or Legally Required Standby Systems: Electronic Trip-Unit Circuit Breakers.

C. Branch Overcurrent Protective Devices: Thermal-Magnetic; Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

E. Surge Protection Device: Where indicated on Drawings. IEEE C62.41-compliant, externally mounted, bolt-on, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, second edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits, with individually fused metal-oxide varistors.

2.06 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Electronic Trip Circuit Breakers: RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
3. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration. Provide as indicated and as required by NFPA 70 for personnel protection.
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Breaker handle indicates tripped status.
    c. UL listed for reverse connection without restrictive line or load ratings.
    d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

g. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

h. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.07 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amerage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.08 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Examine roughing-in of conduits to verify the following:

1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

E. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Panelboards with circuit breakers installed before the building has been completed and cleaned shall be masked.

C. Equipment Mounting: Install panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Mount top of trim 74 inches above finished floor unless otherwise indicated. Panelboards of extra height shall be installed at least 18 inches above floor.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. For Recessed Panels: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade. Paint trim to match wall.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties. All wiring shall be properly formed; no splices are permitted in gutters.

K. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Panelboard Directory: Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. A directory of each panelboard shall be completed and available for review by Engineer during final punch list inspection. Provide description of load and location (i.e. “Lighting, East Wall, Room 101”).

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

A. Tighten bus joints, electrical connectors, and terminals according to manufacturer's published torque-tightening values.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Perform factory start-up of panelboards.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Instruments and Equipment:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. All dust and debris shall be removed from the panels before they are energized and placed into service.

C. All panelboard fronts shall be omitted until final punch list inspection is conducted. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

D. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Remove all temporary markings and labels.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

E. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions. Maintain a clean dry space with uniform temperature in accordance with manufacturer's requirements to prevent condensation.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2416

SECTION 26 2550
GENERATOR DOCKING STATION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes a packaged single-purpose temporary generator docking station to connect a temporary generator to the life safety branch automatic transfer switch in the school.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.

2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

D. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

E. Warranty: Special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

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 NFPA 70.

C. UL 1008 or ETL Listed to UL 1008 Standards.

D. Comply with NEC 700.3(F)

E. UL 508A NEMA 3R Enclosure

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of docking station and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. The equipment installed under this contract shall be left in proper working order. Replace, without additional charge, new work or material which develops defects from ordinary use within one year.

C. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.01 GENERATOR CAMLOCK DOCKING STATION (65KA)

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Power Temp Systems.
   2. Trystar.
   3. ASCO.

2.02 GENERAL REQUIREMENTS

A. A set of Camlocks shall be provided for each of the following:
   1. Portable Generator

B. Protective Caps
   1. All Camlocks shall be protected with spring-loaded weather-proof flip covers that are clear in color to allow for easy viewing of phase color and gender.

C. Enclosures:
   1. Wall, Bottom/Side/Top Cable Entry, NEMA 3R rain-tight, stainless-steel enclosure with rake system for cable entry at the bottom.
   2. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
   3. NEMA 3R integrity shall be maintained while temporary cabling is connected during use.
   4. Front and side shall be accessible for maintenance.
   5. Top, side, and bottom shall be accessible for permanent cabling.
   6. Finishes:
      a. Paint after fabrication. Powder coated Hammer Gray or Black.

D. Phase, Neutral, and Ground Buses:
   1. Material: Silver-plated copper.
   2. Equipment Ground Bus: Bonded to box.
   3. Isolated Ground Bus: Insulated from box.
   4. Ground Bus: 50% of phase size.
   5. Neutral Bus: Neutral bus rated 100 percent of phase bus.
   6. Round edges on bus.

E. Temporary generator connectors shall be Camlock style mounted on gland plate.
   1. Camlock shall be 16 Series model and color coded according to system voltage requirements.
   2. Camlock connections shall be Bus Bar Style, Cabling or Double Set Screw is not acceptable.
   3. Camlock connection shall be protected against accidental contact while not in use.

F. Permanent Connection shall be factory installed broad range set-screw mechanical type, located behind a physical barrier.

G. Short Circuit and Withstand Rating: Minimum 65 kAIC unless otherwise indicated on Drawings.

H. Voltage & Amperage: 480/277V, 3-phase, refer to Drawings for amperage.

I. Factory Installed Phase Rotation Monitor Device: Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed.

J. Additional accessories shall be included in submittal drawing as follows:

1. K#: Kirk Key Door Interlock. The door of the enclosure shall be kirk key interlocked with the main breaker on the permanent generator feeding the Life Safety ATS.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive Generator Docking Station for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Surface, Flush or Base Mounted: Specified with order.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Generator Docking Station vendor shall be required to send a technical representative to the job site to inspect and review installation to ensure it meets the requirements of the consulting engineer.

B. Prepare inspection report that identifies Generator Docking Station with notations of any remedial action taken to correct any issues.

END OF SECTION 26 2550

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, receptacles with integral USB, and associated device plates.
2. Twist-locking receptacles.
3. Weather-resistant receptacles.
4. Snap switches.
5. Wall plates.

B. Related Requirements:

1. Division 26 Section “Lighting Control Devices” for occupancy and vacancy sensor light switches and low-voltage momentary switches.

1.02 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of product.

C. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Arrow-Hart Wiring Devices; Division of Cooper Industries, Inc. (Eaton).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, 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 NFPA 70.

2.03 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; AH5361 (single), AH5362 (duplex).
   b. Hubbell; HBL5361 (single), HBL5362 (duplex).
   c. Leviton; 5361 (single), 5362 (duplex).
   d. Pass & Seymour; 5361 (single), 5362 (duplex).

2.04 USB CHARGER DEVICES

A. USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.

1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
2. USB Receptacles with Line Voltage Receptacles: Dual, Type A USB with dual, two-pole, three-wire, and self-grounding.
3. USB Receptacles Stand-Alone: Quad, Type A.

2.05 GFCI RECEPTACLES

A. General Description:

1. Straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; VGF20.
   b. Hubbell; GFR5352.
   c. Pass & Seymour; 2095.
   d. Leviton; 6898.

2.06 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Eaton; CWL520R.
   b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L520R.

B. Single Convenience Receptacles, 125 V, 30 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-30R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eaton; CWL530R.

b. Hubbell; HBL2310.

c. Leviton; 2310.

d. Pass & Seymour; L530R.

2.07 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.08 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Single Pole:

1) Eaton; AH1221.

2) Hubbell; HBL1221.

3) Leviton; 1221-2.

4) Pass & Seymour; CSB20AC1.

b. Two Pole:

1) Eaton; AH1222.

2) Hubbell; HBL1222.

3) Leviton; 1222-2.

4) Pass & Seymour; CSB20AC2.

c. Three Way:

1) Eaton; AH1223.

2) Hubbell; HBL1223.

3) Leviton; 1223-2.

4) Pass & Seymour; CSB20AC3.

d. Four Way:

1) Eaton; AH1224.

2) Hubbell; HBL1224.

3) Leviton; 1224-2.

4) Pass & Seymour; CSB20AC4.

C. Key-Operated Switches:

1. Line Voltage 120/277 V, 20 A:

a. Products: Subject to compliance with requirements, provide one of the following:

1) Pass & Seymour; PS20AC1-L.

b. Description: Single pole, with factory-supplied key in lieu of switch handle.

c. For low-voltage lighting control systems, key switch shall be wired as a maintained contact, low-voltage switch in the lighting control system. See Drawings for detail.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Eaton; 1995.

b. Hubbell; HBL1557.

c. Leviton; 1257.

d. Pass & Seymour; 1251.

2.09 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.

3. Material for Pool Area and Pool Equipment Area: Smooth, high-impact thermoplastic (nylon).

4. Material for Unfinished Spaces: Galvanized steel.

5. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.10 FLOOR SERVICE FITTINGS

A. Flush-Type Service Fittings:

1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used.

2. Compartments: Barrier separates power from voice and data communication cabling.

3. Service Plate: Rectangular, die-cast aluminum with satin finish.

4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in Division 27 Section "Voice Data System."

2.11 POWER PEDESTALS

A. Basis-of-Design Product: The design for power pedestals and components is based on the Wiremold® Power Pedestals manufactured by Legrand/Wiremold.

B. Outdoor power pedestals provided with two devices.

1. Supplied with color-matched door that can be easily replaced by a color-matched locking door or a transparent door.

2. Interior illuminates when door is open. Door closes automatically to meet while-in-use requirements.

C. Two-Gang Outdoor Power Pedestal: Catalog No. XCSPP2GRU-[XX] with one (1) 20A weather-resistant GFCI and one (1) 4-port 4.2A USB outlets; powder coat finish, verify color with Architect.

2.12 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: White unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.03 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use adhesive P-touch label with machine printed black lettering on both the face of plate and the backside of the plate.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813
FUSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, and enclosed controllers.
2. Spare-fuse cabinets.

1.02 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “ Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Fuse Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current curves, coordination charts and tables, and related data. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc.
5. Tabulated schedule which indicates type, characteristics, and ratings of individual fuses and lists the devices and equipment in which they will be applied.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
B. 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.
C. Comply with NEMA FU 1 for cartridge fuses.
D. Comply with NFPA 70.
E. Comply with UL 248-11 for plug fuses.

1.07 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.08 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.
5. Manufacturer: Bussmann model SFC or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay, Bussmann Hi-Cap Time Delay Fuses KRP-C.
2. Feeders: Class RK1, time delay, Bussmann Low-Peak Dual Element Fuses LPS-RK.
3. Motor Branch Circuits: Class RK1, time delay, Bussmann Low Peak Dual Element Fuses LPN-RK (250V) or LPS-RK (600V).
4. Other Branch Circuits: Class RK1, time delay.
5. Control Circuits: Class CC, fast acting.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

B. Install labels indicating Type and Rating of fuse installed on outside of door of each fused switch.

END OF SECTION 26 2813

SECTION 26 2816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Non-fusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.02 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. GFEP: Ground-fault equipment protection.

C. HD: Heavy duty.

D. NC: Normally closed.

E. NO: Normally open.

F. RMS: Root mean square.

G. SPDT: Single pole, double throw.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Enclosed Switches and Circuit Breaker Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Administrative Requirements” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule

required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Time-current curves for each type of overcurrent protection device. Include hardcopy of characteristic curve and TCC Number for use with Power Tools by SKM Systems Analysis, Inc.

E. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Manufacturer's field service report.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Manufacturer's routing maintenance requirements for enclosed switches and circuit breakers and all installed components.
3. Time-current curves, including selectable ranges for each type of circuit breaker. Include directory listing each adjustable breaker included in the Work and their final set points.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.08 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.

2. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

B. Installation Pathway: Coordinate delivery of equipment to allow movement into designated space.

1. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

2. Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving equipment into place.

C. Store equipment indoors in clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

D. Handle equipment components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate ratings with utilization equipment nameplate limitations of maximum overcurrent protection device size. Provide enclosed switch or circuit breakers to match utilization equipment requirements.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.
8. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   4. Hookstick Handle: Allows use of a hookstick to operate the handle.
   5. Lugs: Mechanical type, suitable for number, size, and conductor material.
   6. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. ABB (General Electric Company); Industrial Connections & Solutions, LLC.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.

E. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

2.04 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
   3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

B. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat, undersurfaces treated with corrosion-resistant undercoating.

C. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard ANSI Gray enamel over corrosion-resistant treatment or rust-inhibiting primer coat.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of conduits to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Fused Power Circuit Device Operating Mechanism: Mechanical Trip, except Electrical Trip for switches with ground-fault protection or remotely tripped switches.

B. Molded-Case Circuit Breakers OCPD Type: Thermal-Magnetic Circuit Breakers, unless otherwise indicated.

3.03 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

E. Anchor floor-mounting switches to concrete base.

F. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

G. Mount plumb and rigid without distortion of box. Mount recessed equipment with fronts uniformly flush with wall finish.

H. Install filler plates in unused spaces.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

J. Close unused conduit opening or other unused holes in sides of box with proper mating blank-off plates.

K. Do not use gutters of equipment as raceways for routing feeder conductors from bottom entrance to top-feed lugs or vice versa; an external gutter or conduit shall be used for this purpose.

3.04 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable overcurrent protection device trip characteristics according to settings provided by Engineer-of-Record.

1. Settings will be provided by Engineer-of-Record after the submittal process and review of report required by Division 26 Section "Overcurrent Protective Device Studies." are completed.

3.07 CLEANING

A. Clean components according to manufacturer's written instructions.

B. Prior to installation of front trim and cover plates inspect interior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

C. On completion of front trim and cover installation, inspect exterior surfaces and perform the following:

1. Remove paint splatters and other spots.
2. Remove all temporary markings and labels.
3. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
4. Repair exposed surfaces to match original finish.

3.08 PROTECTION

A. Temporary Heating: Maintain a clean dry space with uniform temperature in accordance with manufacturer’s requirements to prevent condensation. Apply temporary heating as required.

B. Protect equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

END OF SECTION 26 2816

SECTION 26 3213
ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes packaged engine-generator sets for emergency power supply with the following features:

1. Gas engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.02 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. LP: Liquid petroleum.

1.03 PERFORMANCE REQUIREMENTS

A. Overcurrent Protective Device Coordination for Emergency Systems and Legally Required Standby Systems: All overcurrent protective devices proposed for inclusion in the Work on the Emergency Systems branch (NEC Article 700) and the Legally Required Standby System branch (NEC Article 701) shall be selected to be selectively coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for both normal and emergency power. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

B. Overcurrent Protective Device Coordination: All other overcurrent protective devices proposed for inclusion in the Work shall be selected to be coordinated with the overcurrent protective devices installed on their supply side such that an overcurrent event (overload, short-circuit, or ground-fault) occurring at the lowest level in the system (branch circuit) cannot cause the feeder protective device supplying the branch circuit panelboard to open. This coordination shall be carried through each level of distribution for all branches of normal and emergency power to 0.10 seconds. Refer to Division 26 Section "Overcurrent Protective Device Studies" for additional requirements.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Engine Generator Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to

adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor's failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

E. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Wiring Diagrams: Power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, manufacturer, and testing agency.

B. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

C. Field quality-control test reports.

D. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. 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.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.08 QUALITY ASSURANCE

A. General Requirements: It is the intent of this specification to secure an emergency generator system that has been prototype tested, factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the plans and drawings, and specifications herein. The equipment supplied and installed shall meet the requirements of the National Electrical Code, along with all applicable local codes and regulations. All equipment shall be new, of current productions of a national firm. The standby generator set(s) including generator, controls, and transfer switch(es), shall be assembled as a matched unit so that there is a one-source responsibility for warranty, parts, and service without a local representative with factory-trained servicemen.

B. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.

2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

C. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with ASME B15.1.

G. Comply with NFPA 37, NFPA 70, NFPA 101, and NFPA 110 requirements for Level 1 emergency power supply system.

H. Comply with UL 2200.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.09 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 5 to 40 deg C.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1000 feet.

1.10 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years or 1500 hours, whichever occurs first, from date of Substantial Completion.
2. For standby power applications, the complete electrical power system (generator set, controls and associated switches, switchgear and accessories), as provided by the single-source manufacturer, shall be warranted by said manufacturer against defects in materials and workmanship for the above warranty period.
3. Said coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment.
4. There shall be no deductibles applied to said warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar; Engine Div.
2. Cummins Power Generation; Industrial Business Group.
3. Kohler.

2.02 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.03 ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Manufacturer: Engine shall be the same manufacturer as the engine-generator set manufacturer.

E. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

I. Muffler: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 95 dBA or less.

J. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 12-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.04 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the “AUTO” position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the “START” position, generator set starts and accelerates to rated speed and voltage. The “STOP” position of same switch initiates generator-set shutdown and shall immediately stop, bypassing all time delays. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and Protective Devices and Controls:

1. As required by NFPA 110 for Level 1 system, and the following:
    a. AC voltmeter.
    b. AC ammeter.
    c. AC frequency meter.
    d. DC voltmeter (alternator battery charging).
    e. Engine-coolant temperature gage.
    f. Engine lubricating-oil pressure gage.
    g. Running-time meter.
    h. Ammeter-voltmeter, phase-selector switch(es).
    i. Generator-voltage adjusting rheostat.
2. Alarm and status indicating lamps to indicate non-automatic generator status and existing alarm and shutdown conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on the display panel:
    a. Switch off (flashing)
    b. Low oil pressure (alarm)
    c. Low oil pressure (shutdown)
    d. Low coolant temperature (alarm)
    e. High coolant temperature (alarm)
    f. High coolant temperature (shutdown)
    g. Low coolant level (shutdown)
    h. Overcrank (shutdown)
    i. Overspeed (shutdown)

D. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

F. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.

7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Low cranking voltage alarm.

G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.05 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, electronic trip type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection to protect the generator from damage due to its own high current capability.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Kirk Key Door Interlock: The main breaker on the permanent life-safety generator feeding the Life Safety ATS shall be kirk key interlocked with the enclosure door of the generator docking station for a temporary generator connection.
5. Mounting: Adjacent to or integrated with control and monitoring panel.
6. Coordination: Must meet selective coordination requirements as outlined in Performance Requirements section above to allow selective tripping of downstream circuit breakers under a fault condition.
7. This breaker shall not automatically reset preventing restoration of voltage if maintenance is being performed.

2.06 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Enclosure: Dripproof.

G. Instrument Transformers: Mounted within generator enclosure.

H. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 2 percent adjustment of output-voltage operating band at any constant load from 0 to 100 percent of rating.

2. Regulator must be isolated to prevent tracking when connected to SCR loads and provide individual adjustments for voltage range, stability and volts-per-hertz operation.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof, stainless-steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.08 MOTORS

A. General requirements for motors are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

2.09 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Full load run.

3. Maximum power.

4. Voltage regulation.

5. Transient and steady-state governing.

6. Single-step load pickup.

7. Safety shutdown.

8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.03 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.

1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Natural Gas Piping."

E. Connect remote monitoring system to generator and verify functionality. Engage a factory-authorized service representative to assist with programming and setup.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

H. Connect remote monitoring system to generator control panel inside generator enclosure with supplied 5-pin data I/O cable.

3.04 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Load Test: Run generator under full load for a minimum of six (6) hours and record results. Generator shall be capable of delivering full capacity while operating in an ambient temperature of 122 degrees F. Resistive load bank shall be furnished and connected to the generator to achieve a full load per generator capacity.
    a. Record coolant temperature, lube oil pressure, output voltage (each phase), and output current (each phase) at 1-hour intervals.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.
4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
    a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
    b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
    c. Verify acceptance of charge for each element of the battery after discharge.
    d. Verify that measurements are within manufacturer's specifications.
5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Upon completion of load test, operate the generator under actual load conditions connected to the building. Test shall be run for a minimum of two (2) hours.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Provide at least 7-day notice to Owner and Engineer of training date. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 3213

SECTION 26 3600
TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

B. Related Sections include the following:

1. Division 21 Section "Electric-Drive, Centrifugal Fire Pumps" for automatic transfer switches for fire pumps.

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Simultaneous Action Submittals: Transfer Switch Product Data submittal shall be made in conjunction with action submittals required under Division 26 Section “Overcurrent Protective Device Studies.” The release of electrical equipment submittals (panelboards, engine generators, switchgear, etc.) is dependent on the receipt of a complete and accurate overcurrent protective device coordination study. The Architect and Engineer require a full submittal review period as delineated in Division 01 Section “Submittal Procedures” to adequately review the OCPD study against the submitted electrical components prior to release of submittals for equipment procurement. The submittal schedule required by Division 01 requirements shall provide for this review time in the action submittal process. Delay claims arising due to Contractor’s failure to coordinate simultaneous action submittals will not be considered by the Owner.

D. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

E. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

F. Warranty: Special warranty specified in this Section.

1.03 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Field quality-control test reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Closeout Submittals," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.06 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

2. For standby power applications, the complete electrical power system (generator set, controls and associated switches, switchgear and accessories), as provided by the single-source manufacturer, shall be warranted by said manufacturer against defects in materials and workmanship for the above warranty period.

3. Said coverage shall include parts, labor, travel expenses, and labor to remove/reinstall said equipment.

4. There shall be no deductibles applied to said warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Emerson; ASCO Power Technologies, LP.

b. Cummins Power Generation; Industrial Business Group.

c. Russelectric, Inc.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.

2. Switch Action: Double throw; mechanically held in both directions.

3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral Terminal: Solid and fully rated unless otherwise indicated.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

H. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.04 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Identify components according to Division 26 Section "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    a. Verify grounding connections and locations and ratings of sensors.
7. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
8. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

9. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.
10. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
11. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
    a. Verify grounding connections and locations and ratings of sensors.

B. Coordinate tests with tests of generator and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

D. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
    1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600

SECTION 26 4313
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:

1. Section 26 2413 Switchboards for factory installed SPDs.
2. Section 26 2416 Panelboards for field installed SPDs.

1.02 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. I-nominal: Nominal discharge current.

C. MCOV: Maximum continuous operating voltage.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SVR: Suppressed voltage rating.

H. SPD: Surge Protective Device(s), both singular and plural; also, transient voltage surge suppression.

I. VPR: Voltage protection rating.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, clamp times, physical construction, operating weights, electrical characteristics, furnished specialties, and accessories. Include UL 1449, 3rd Edition Listing documentation verifying:

1. Short Circuit Current Rating (SCCR).
2. Voltage Protection Ratings (VPRs) for all modes.
3. Maximum Continuous Operating Voltage rating (MCOV). The MCOV shall be a tested value per UL 1449 3rd Edition, section 37 .7.3. MCOV values based solely on the components used in the construction of the SPD will not be accepted.
4. I-nominal rating (I-n).
5. Type 1 or Type 2 Device Listing.
6. Manufacturer shall provide written test report showing the SPD can survive a single surge at its raged value without the use of circuit breakers or fuses. Single surge ratings based on the sum of components used in the construction of the SPD will not be acceptable.
7. kA rating per phase.
8. kA rating per mode.

D. Warranty: Special warranty specified in this Section.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Certificates: For SPD devices, from manufacturer.

C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

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

1.06 QUALITY ASSURANCE

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

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1449, 3rd Edition.

E. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.08 COORDINATION

A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Fifteen (15) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ACT Communications, Inc.
2. Current Technology Inc.; Danaher Power Solutions.
3. Danaher Power Solutions; United Power Products.
4. Liebert Corporation; a division of Emerson Network Power.
5. Southern Tier Technologies.

B. Surge Protection Devices:

1. Comply with UL 1449, Type 1.
2. Modular design (with field-replaceable modules).

3. Internal Device Overcurrent Protection (Fuses): All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2T capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.
4. Each MOV shall be individually fuse protected to avoid cascading faults.
5. Fabrication using bolted compression lugs for internal wiring.
6. Integral disconnect switch.
7. Redundant suppression circuits.
8. Redundant replaceable modules.
9. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
10. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
11. LED indicator lights for power and protection status.
12. Audible alarm, with silencing switch, to indicate when protection has failed.
13. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
14. Six-digit transient-event counter set to totalize transient surges.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 200,000 A.
2. Line to Ground: 200,000 A.
3. Line to Line: 200,000 A.
4. Neutral to Ground: 200,000 A.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, 3-phase, 4-wire circuits shall be as follows:
1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.
4. Neutral to Ground: 1200V for 480Y/277 V.

F. SCCR: Equal or exceed 200 kA.

G. I-nominal Rating: UL labeled with 20 kA nominal for compliance with UL 96A Lightning Protection Master Label and NFPA 780.

2.02 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ACT Communications, Inc.
   2. Current Technology Inc.; Danaher Power Solutions.
   3. Danaher Power Solutions; United Power Products.
   4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   6. Liebert Corporation; a division of Emerson Network Power.
   7. Siemens Energy & Automation, Inc.
   8. Southern Tier Technologies.
   9. Square D; a brand of Schneider Electric.

B. Surge Protection Devices:
   1. Comply with UL 1449, Type 2.
   2. Modular design (with field-replaceable modules).
   3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
   4. Internal Device Overcurrent Protection (Fuses): All protection modes (including Neutral to Ground) of each surge suppression device shall be internally fused at the component level with fuse I^2T capability allowing the suppressor's maximum rated transient current to pass through the suppressor without fuse operation. If the rated I^2T characteristic of the fusing is exceeded, the fusing shall be capable of opening in less than one millisecond and clear both high and low impedance fault conditions. The fusing shall be capable of interrupting up to 200 kA symmetrical fault current with 600 VAC applied. This overcurrent protection circuit shall be monitored to provide indication of suppression failure. Conductor level fuses or circuit breakers internal or external to the surge suppression units are not acceptable as meeting this requirement.
   5. Each MOV shall be individually fuse protected to avoid cascading faults
   6. Fabrication using bolted compression lugs for internal wiring.
   7. Redundant suppression circuits.
   8. Redundant replaceable modules.
   9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
   10. LED indicator lights for power and protection status.
   11. Audible alarm, with silencing switch, to indicate when protection has failed.
   12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   13. Four-digit transient-event counter set to totalize transient surges.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:

1. Line to Neutral: 100,000 A.
2. Line to Ground: 100,000 A.
3. Line to Line: 100,000 A.
4. Neutral to Ground: 100,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V or 208Y/120 V, 3-phase, 4-wire circuits shall not exceed the follows:

1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.

F. SCCR: Equal or exceed 100 kA.

2.03 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.

1. Provide direct tap off load side of main bus in switchboard. Utilize #2/0 AWG wire for connection to switchboard with maximum wire length of three feet.

B. Install SPD devices for panelboards and auxiliary panels conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide 30-A circuit breaker as a dedicated disconnecting means for SPD unless otherwise indicated. Utilize #8 AWG wire for connection to panelboard with maximum wire length of three feet.

C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing SPD devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

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

E. Prepare test and inspection reports.

3.03 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Do not energize or connect service entrance equipment or panelboards to their sources until SPD devices are installed and connected.

END OF SECTION 26 4313

SECTION 26 5100
INTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior lighting fixtures.
2. Building mounted exterior lighting fixtures.
3. Exit signs.
4. Lighting fixture supports and accessories.

1.02 DESCRIPTION OF WORK

A. This work consists of providing all labor, materials, accessories, mounting hardware and equipment necessary for an operationally and aesthetically complete installation of all luminaries, including accessories, in accordance with the contract documents.

B. Furnish and install all lighting fixtures, as herein specified, complete with lamps, drivers, power supplies, ballasts and accessories for safe and effective operation. All fixtures shall be installed and left in an operable condition with no broken, damaged or soiled parts.

C. All items furnished shall comply with the latest applicable standards applicable, including UL, NEMA and ETL, and shall bear labels accordingly.

D. All fixtures shall be the color specified or as selected by the Architect during shop drawing review. Wherever fixtures have evident damage, they shall be restored to new condition or shall be replaced. Likewise, fixtures showing dirt, dust or finger prints shall be restored to new condition or shall be replaced.

E. Specifications and scale drawings are intended to convey all salient features, functions and characteristics of the light fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

F. Minor details, not usually indicated on the drawings nor specified, but that are necessary for proper execution and completion of the luminaries, shall be included, the same as if they were herein specified or indicated on the drawings.

G. The Owner, Architect and Engineer shall not be held responsible for the omission or absence of any detail, construction feature, etc. which may be required in the production of the light fixtures. The responsibility of accurately fabricating the light fixtures to the fulfillment of the specification rests with the Contractor.

H. Where emergency battery packs are provided with fixtures (if any), they shall be connected to an unswitched power line and wired in accord with applicable codes and the manufacturer's recommendations.

I. Refer to architectural details as applicable for recessed soffit fixtures or wherever fixture installations depend upon work of other trades. Coordinate all installations with other trades. Verify dimensions of spaces for fixtures, and if necessary, adjust lengths to assure proper fit and illumination of diffuser and/or area below.

J. Pre-manufactured flexible wiring systems are not permitted for this project.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. DLC: DesignLights Consortium.

E. IECC: international Energy Conservation Code.

F. LED: Light emitting diode.

G. LER: Luminaire efficacy rating.

H. Lumen: Measured output of lamp and luminaire, or both.

I. Luminaire: Complete lighting fixture, including ballast housing if provided.

J. RCR: Room cavity ratio.

K. UL: Underwriters Laboratory

1.04 REFERENCE STANDARDS

A. IESNA LM-80 – Measuring Lumen Maintenance of LED Light Sources.

B. IESNA HB-10 – IES Lighting Handbook – Tenth Edition.

C. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

D. NFPA 101 – Life Safety Code

E. NFPA 70 – National Electrical Code.

F. UL 924 – Standard for Emergency Lighting and Power Equipment.

G. UL 1310 – Standard for Safety Class 2 Power Units.

H. UL 1598 – Luminaires.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section "Electrical Shop Drawings and Submittals" for products specified under PART 2 – PRODUCTS.

B. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Energy-efficiency data.
4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.

C. Installation instructions.

D. Warranty: Sample copy of warranty.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

B. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

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

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

2. Submit operation and maintenance data in accordance with IECC and as specified herein, showing all light fixtures, control devices and all interconnecting control wire, conduit and associated hardware.
3. Contractor shall be responsible for obtaining from his supplying light fixture manufacturers, for each type of light fixture, a recommended maintenance manual including, tools required, types of cleaners to be used and replacement parts identification list.

B. Warranty: Copy of warranty.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Provide entire fixture attic stock as indicated on the Lighting Fixture Schedule on the Drawings.

1.09 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

B. 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.

C. Comply with NFPA 70.

D. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, “shall” had been substituted for “should” wherever it appears. Interpret references in these publications to the “Authority Having Jurisdiction,” equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 and NEMA unless more stringent requirements are specified or indicated.

E. Luminaire drawings shall include dimensions, accessories, and installation and construction details. Photometric data, including zonal lumen data, average and minimum ratio, aiming diagrams and computerized candlepower distribution data shall accompany shop drawings.

F. Fixtures shall be DLC or Energy Star rated/listed.

1.10 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.11 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
1. All light fixtures/luminaries and controls shall have an unconditional 10-year warranty. Contractor shall warrant light fixtures, lamps, drivers, finishes and all components to be free from defects in materials and workmanship for a period of ten (10) years from date of Owner’s acceptance. Replacement of light fixtures and cost of labor shall be the responsibility of the Contractor.
2. Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and

run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

3. Light fixtures and associated equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

4. Furnish the electronic LED driver manufacturer's warranty. The warranty period shall not be less than 10 years from the date of substantial completion of the electronic LED driver. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.

B. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

2.02 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

   b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

F. Provide in-line fuse-holders with fuses sized per manufacturer's recommendation for each fixture.

G. All light fixtures shall be completely wired at the factory in accordance with applicable codes and UL.

H. All trims and canopies shall fit snugly and securely to the ceiling so that no light leak occurs.

I. Exterior building mounted light fixtures shall be UL classified for damp or wet locations as applicable and shall be complete with gaskets, cast aluminum outlet box and grounding. All dissimilar metal materials shall be separated by non-conductive materials to prevent galvanic action.

J. Factory-Applied Labels: Comply with UL 1598. All light fixtures shall be clearly marked for operation of specific LED's and drivers according to proper type. The following characteristics shall be noted in the format "Use Only _____":

1. LED type, and nominal wattage for light fixture.
2. Driver type.
3. Correlated color temperature (CCT) and color rendering index (CRI) for light fixtures.
4. All markings related to lamp type shall be clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Ballasts shall have clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

K. Provide "maximum wattage label" on all light fixture based on the specified maximum wattage indicated on the light fixture schedule.

L. Each light fixture shall be packaged with complete instructions and illustrations on how to install.

M. Each light fixture box, container, etc shall be labeled at the factory with the type designation as indicated on the Light Fixture Schedule.

2.03 LIGHT EMITTING DIODE (LED)

A. Light emitting diodes shall be tested under IES LM-80 standards.

B. Color Rendering Index (CRI) shall be 80 (minimum).

C. Color temperature of 4000K, or as indicated on light fixture schedule.

D. Rated lumen maintenance of 90% lumen output at 50,000 hours (minimum).

E. Rated lumen maintenance of 70% lumen output at 100,000 hours (minimum).

F. Provide light fixture types that the LED boards and drivers can be re-placed from the bottom and below ceiling. Trim for the exposed surface of flush-mounted fixtures shall be white or as indicated on light fixture schedule.

2.04 LIGHT EMITTING DIODE (LED) ELECTRONIC DRIVERS

A. Driver shall comply with UL 1310 Class 2 requirements for dry and damp locations, NFPA 70 unless specified otherwise. Drives shall be designed for the wattage of the LEDs used in the indicated application. Drivers shall be designed to operate on the voltage system to which they are connected.

B. Power factor shall be 0.95 (minimum).

C. Class A Sound Rating.

D. Current crest Factor of 1.5 or less.

E. Total harmonic distortion (THD): Shall be 20 percent (maximum).

2.05 SUSPENDED FIXTURES

A. Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers.

B. Provide with swivel hangers to ensure a plumb installation.

C. Hangers shall be cadmium-plated steel with a swivel-ball tapped for the conduit size indicated.

D. Hangers shall allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer to limit swinging.

E. Single-unit suspended fixtures shall have twin-stem hangers.

F. Multiple-unit or continuous row fixtures shall have a tubing or stem for wiring at one point and a tubing or rod suspension provided for each unit length of chassis, including one at each end.

G. Rods shall be a minimum 0.18-inch diameter.

2.06 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924, NFPA 70, and NFPA 101; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    f. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

C. Provide single or double face as scheduled, indicated on plans or as required by the local Authority Having Jurisdiction. Adjust installation position if required for clear visibility, in accordance with applicable codes.

D. Provide directional arrows (chevrons) as indicated on floor plans and to suit the means of egress or as required by the local Authority Having Jurisdiction

2.07 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Mounting heights specified or indicated shall be to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures.

3. Install in accordance with light fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation", and NEMA standards.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Lay-in Ceiling Lighting Fixtures Supports:

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
4. Install at least four independent support wires from structure to a tab on lighting fixture located near each corner of each fixture. Wire shall have breaking strength of the weight of fixture at a safety factor of 3. Round fixtures or fixtures smaller in size than the ceiling grid shall be independently supported from the building structure by minimum of four wires per fixture spaced approximately equidistant around the fixture.
    a. Support light fixtures with four (4) wires, with one (1) at each corner. Hanger wires shall be installed within 15 degrees of plumb or additional support shall be provided. Wires shall be attached to fixture body and to the building structure (not to the supports of other work or equipment).
    b. Where building structure is located such that 15 degrees cannot be maintained, the Contractor shall provide "Uni-strut" or similar structure to meet this requirement.
    c. Support Clips: All light fixtures shall be furnished with hold down clips to meet applicable seismic codes. Provide four (4) clips per fixture minimum or the equivalent thereof in the installation trim. Fasten to light fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application. Contractor shall install clips per manufacturer's requirements. If screws are required, they shall be provided.

D. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
    a. Suspended fixtures in continuous rows shall have internal wireway systems for end to end wiring and shall be properly aligned to provide a straight and continuous row without bends, gaps, light leaks or filler pieces.
    b. Aligning splines shall be used on extruded aluminum fixtures to assure hairline joints.
    c. Steel fixtures shall be supported to prevent "oil-canning" effects.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
5. Pendants shall be finished to match fixtures.
6. Aircraft cable shall be stainless steel.

7. Canopies shall be finished to match the ceiling and shall be low profile unless otherwise shown.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Wire exit signs ahead of the switch to the un-switched emergency lighting life-safety branch circuit located in the same room or area.

G. Exterior building mounted light fixtures shall not be installed until after the building exterior has been rinsed clean of any corrosive cleaning materials. Damaged fixtures shall be replaced by the Contractor at no cost.

H. Light fixture whips shall be supported from the building structure. Do not clip to lay-in ceiling support wires.

I. Light fixture locations in mechanical and electrical equipment rooms/areas, as indicated on floor plans, are approximate. Locate light fixtures to avoid equipment, ductwork, and piping. Locate around and between equipment to maximize the available light. Coordinate mounting heights and locations of light fixtures to clear equipment. Request a meeting with the Engineer if uncertain about an installation. All suspended light fixtures shall be mounted square and plumb.

J. All reflecting surfaces, glass or plastic lenses, driver housings, louvers, downlighting alzak cones and specular reflectors shall be handled with care during installation or lamping to avoid fingerprints or dirt deposits. It is preferred that louvers be shipped and installed with clear plastic bags to protect louvers. At close of project, and after construction air filters are changed, remove bags.

3.02 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.03 CLEANING

A. At the time of final acceptance by the Owner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturer.

B. Any louver or cone showing dirt or fingerprints shall be cleaned with solvent recommended by the manufacturer to a like-new condition, or replaced as necessary in order to turn over to the Owner new fixtures at beneficial occupancy.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

B. Electronic Dimming Drivers. Test for full range of dimming capability. Observe for visually detectable flicker over full dimming range.

C. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

D. Inspect each light fixture for damage. Replace damaged light fixtures at no cost to the Owner.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 5100

SECTION 26 5613
LIGHTING POLES AND STANDARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

B. Related Requirements:

1. Division 26 Section “LED Exterior Lighting” for exterior solid-state luminaires that are to be installed throughout the site.

1.02 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete luminaire.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each pole, accessory, and luminaire-supporting device, arranged as indicated.

1. Include data on construction details, profiles, EPA, cable entrances, materials, dimensions, weight, rated design load, and ultimate strength of individual components.
2. Include finishes for lighting poles and luminaire-supporting devices.
3. Anchor bolts.
4. Manufactured pole foundations.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of poles and pole accessories.
4. Foundation construction details, including material descriptions, dimensions, anchor bolts, support devices, and calculations, signed and sealed by a professional engineer licensed in the state of installation.
5. Anchor bolt templates keyed to specific poles and certified by manufacturer.
6. Method and procedure of pole installation. Include manufacturer's written installations.

D. Warranty: Sample copy of warranty.

1.04 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations signed and sealed by a professional engineer.

B. Qualification Data: For Installer.

C. Material Test Reports:

1. For each foundation component, by a qualified testing agency.

2. For each pole, by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Soil test reports.

1.05 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Division 01 Section "Closeout Submittals," include pole inspection and repair procedures.

B. Warranty: Copy of warranty.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Pole repair materials.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for foundation testing.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store poles on decay-resistant skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

1.09 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Characteristics: Comply with AASHTO LTS-6-M.

1. The effects of fatigue shall be considered during design at the equivalent static wind pressure as determined by AASHTO LTS-6-M with the fatigue importance factor indicated.

2. Fatigue Category I.

3. Maximum permitted stresses for the fatigue analysis shall be based on an infinite number of cycles as determined by ANSI/AISC 360-10, including Appendix 3.

B. Dead Load: Weight of luminaire and its horizontal and vertical supports and supporting structure, applied according to AASHTO LTS-6-M.

C. Wind Load: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be designed to resist wind loads as determined by ASCE 7-10 based on a Wind Speed (3 second gust) as indicated for the Project location in the Mapped Basic Wind Speeds for Risk Category and Exposure Category indicated. Luminaires, visors and crossarms shall be designed to resist wind loads while maintaining luminaire aiming alignment. All designs shall comply with the 2012 International Building Code (IBC).

1. Ultimate Wind Speed: 151 mph (3-second gust)

2. Nominal Wind Speed: 117 mph (3-second gust)

3. Risk Category: III

4. Exposure Category: C

D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.02 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig; one-piece construction up to 40 feet in height with access handhole in pole wall.

1. Shape: Square, tapered.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Square with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

F. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
   a. Color: As selected by Architect from manufacturer's full range.

2.03 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Headed rods.
3. Threading: Uniform National Coarse, Class 2A.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two nuts provided per anchor bolt, shipped with nuts pre-assembled to the anchor bolts.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.
2. Two washers provided per anchor bolt.

2.04 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C. Examine roughing-in for foundation and conduit to verify actual locations of installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 POLE FOUNDATION

A. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123 M; and with top-plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Anchor Bolts: Install plumb using manufacturer-supplied steel template, uniformly spaced.

3.03 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on drawing.

1. Fire Hydrants and Water Piping: 60 inches.
2. Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Install base covers unless otherwise indicated.
3. Use a short piece of 1/2 -inch diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Poles and Pole Foundations Set in Concrete-Paved Areas: Install poles with a minimum 6-inch-wide, unpaved gap between the pole or pole foundation and the edge of the adjacent concrete slab. Fill unpaved ring with pea gravel. Insert material to a level 1 inch below top of concrete slab.

F. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.04 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum using insulating fittings or treatment.

B. Steel Conduits: Comply with requirements in Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50-percent overlap.

3.05 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. Ground Nonmetallic Poles and Support Structures: Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole.
2. Install grounding conductor and conductor protector.
3. Ground metallic components of pole accessories and foundation.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.07 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Inspect poles for nicks, mars, scratches, and other damage.
2. System function tests.

END OF SECTION 26 5613

SECTION 26 5619
LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.

B. Related Requirements:

1. Division 26 Section "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. DLC: DesignLights Consortium.

E. IP: International Protection or Ingress Protection Rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Product Data: For each type of luminaire.

1. Include data on features, accessories, and finishes.
2. Include physical description and dimensions of luminaire.
3. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
4. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79.
    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
5. Wiring diagrams for power, control, and signal wiring.
6. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

E. Warranty: Sample copy of warranty.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

B. Warranty: Copy of warranty information.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide entire fixture attic stock as indicated on the Lighting Fixture Schedule on the Drawings.

1.07 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

E. Fixtures shall be DLC or Energy Star rated/listed.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.09 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. The equipment items shall be supported by service organizations which are reasonably convenient (less than 100 miles from project site) to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1. All light fixtures/luminaries and controls shall have an unconditional 10-year warranty. Contractor shall warrant light fixtures, lamps, drivers, finishes and all components to be free from defects in materials and workmanship for a period of ten (10) years from date of Owner’s acceptance. Replacement of light fixtures and cost of labor shall be the responsibility of the Contractor.

2. Warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under provisions of the Contract Documents and shall be in addition to, and run concurrently with other warranties made by the Contractor under requirements of the Contract Documents.

3. Light fixtures and associated equipment shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render

satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

4. Furnish the electronic LED driver manufacturer's warranty. The warranty period shall not be less than 10 years from the date of substantial completion of the electronic LED driver. The warranty shall state the malfunctioning LED driver shall be exchanged by the manufacturer and promptly shipped to the Owner. The replacement LED driver shall be identical to, or an improvement upon, the original design of the malfunctioning LED driver.

PART 2 - PRODUCTS

2.01 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Lamp base complying with ANSI C81.61 or IEC 60061-1.

E. CRI of minimum 80. CCT of 3000 K.

F. L70 lamp life of 100,000 hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage: 277 V ac.

J. In-line Fusing: On the primary for each luminaire.

K. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

L. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.02 LUMINAIRE TYPES

A. Area and Site:

1. Manufacturers:

   a. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.

   b. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.

2. Luminaire Shape: Square.

3. Mounting: Pole with extruded-aluminum rectangular arm, 7 inches in length.

4. Luminaire-Mounting Height: Refer to Light Fixture Schedule on Drawings.

5. Distribution: Refer to Light Fixture Schedule on Drawings.

6. Housings:

   a. Extruded-aluminum housing and heat sink.

   b. Bronze powder-coat finish, verify color with Architect.

B. Decorative Post Top:

1. Manufacturers:
    a. Subject to compliance with requirements, provide one of the products indicated on Light Fixture Schedule. Refer to Light Fixture Schedule for manufacturers and model numbers. Basis of design for each type shall be the first fixture manufacturer and model number listed for each type.
    b. Manufacturer's catalog numbers together with the descriptions on the drawings and these specifications are indicative of required design, appearance, quality and performance. Refer any discrepancies between any of these to the Engineer for resolution prior to bid. In absence of such notice to the Engineer, provide the greater requirement as directed by the Engineer, without additional cost.
2. Luminaire-Mounting Height: Refer to Light Fixture Schedule on Drawings.
3. Mounting Type: Tenon.
4. Distribution: Refer to Light Fixture Schedule on Drawings.
5. Housings:
    a. Extruded-aluminum housing and heat sink.
    b. Powder-coat finish, verify color with Architect.

2.03 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

F. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter, shape, size, wattage and coating.
    c. CCT and CRI for all luminaires.

2.04 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

a. Color: Verify color with Architect.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Fasten luminaire to structural support.

C. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and relamping.

3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Wiring Method: Install cables in raceways. Conceal raceways and cables.

E. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

F. Coordinate layout and installation of luminaires with other construction.

G. Adjust luminaires that require field adjustment or aiming.

H. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" and Division 26 Section "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.03 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 5619

SECTION 26 5668

EXTERIOR ATHLETIC LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.

B. The purpose of these specifications is to define the lighting system performance and design standards for High School Athletic Fields using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.

C. The sports lighting will be for the following venue:

1. Football Field.
2. Track.
3. Baseball Field.
4. Softball Field.

D. The primary goals of this sports lighting project are:

1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore, light levels are guaranteed for a period of 25 years.
2. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players, spectators and neighbors. The LED design should provide better control than a good HID design.
3. Life-cycle Cost: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
4. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Field should be proactively monitored to detect luminaire outages over a 25-year life-cycle. All communication and monitoring costs for 25-year period shall be included in the bid.

E. All lighting designs shall comply with UIL standards, except where exceeded by this specification, and local lighting ordinances.

1.2 LIGHTING PERFORMANCE

A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with a minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-05-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not drop below desired target values in accordance to IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

Area of Lighting	Average Target Light Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Football	50 footcandles	2.0:1.0	72	30’ x 30’
Track	30 footcandles	5.0:1.0	48	30’ x 30’
Baseball (Infield)	50 footcandles	2.0:1.0	25	30’ x 30’

Baseball (Outfield)	30 footcandles	2.5:1.0	105	30’ x 30’
Baseball (Bullpens)	30 footcandles	2.5:1.0	32/24	10’ X 10’
Baseball (Batting Cage)	30 footcandles	2.5:1.0	16	20’ X 14’
Softball (Infield)	50 footcandles	2.0:1.0	25	20’ X 20’
Softball (Outfield)	30 footcandles	2.5:1.0	86	20’ X 20’
Softball (Bullpens)	30 footcandles	2.5:1.0	18/24	10’ X 10’
Softball (Batting Cage)	30 footcandles	2.5:1.0	16	20’ X 14’

B. Hours of Usage: Designs shall be based on 150 hours annual usage and 3,750 hours over a 25-year usage period.

C. Color: The lighting system shall have a minimum color temperature of 5700K and a CRI of 75.

D. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as follows. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

1. Football: Two (2) 80-feet and two (2) 70-feet
2. Baseball: Two (2) 90-feet, two (2) 80-feet, and two (2) 70-feet
3. Softball: Two (2) 80-feet and two (2) 70-feet

E. Security Fixtures: There shall be security lights on certain poles as shown on the Drawings. The fixture(s) shall be provided by the field lighting manufacturer and integrated into the lighting system structure with remote electrical components located 10-feet above grade. Fixtures to be on a separate circuit from field lighting.

1.3 ENVIRONMENTAL LIGHT CONTROL

A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted.

B. The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified independent testing laboratory with a minimum of five years’ experience or by a manufacturer’s laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

1.4 LIFE-CYCLE COSTS

A. Manufacturer shall submit a 25-year life cycle cost calculation as outlined in the required submittal information.

B. Preventative and Spot Maintenance: Manufacturer shall provide all preventative and spot maintenance, including parts and labor for 25 years from the date of equipment shipment. Individual outages shall be repaired when the usage of any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

1.5 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 26 Section “Electrical Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 26 Section “Electrical Shop Drawings and Submittals”.

C. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES LM-79.
    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
6. Wiring diagrams for power, control, and signal wiring.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

F. Warranty: Sample of special warranty.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

B. Warranty: Copy of special warranty.

1.8 WARRANTY AND GUARANTEE

A. 25-Year Warranty: Manufacturer shall supply a signed warranty covering the entire system for 25 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather condition events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.

B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage or any field is materially impacted. Owner agrees to check fuses in the event of a luminaire outage.

PART 2 - PRODUCT

2.1 MANUFACTURER

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Musco Lighting.

B. Design Approval: The Owner and Engineer will review shop drawings from the manufacturer to ensure compliance to the specification.

2.2 LIGHTING SYSTEM CONSTRUCTION

A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.

B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.

C. System Description: Lighting system shall consist of the following:

1. Galvanized steel poles and cross arm assembly
2. Non-approved pole technology:
    a. Square static cast concrete poles.
    b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long-term performance concerns.
3. Lighting systems shall use concrete foundations as defined below:
    a. For a foundation using pre-stressed concrete base embedded in concrete backfill, the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
    b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or re-enforced pier design, pole erection may occur after 7 days or after a concrete sample from the same batch achieves a certain strength.
4. Manufacturer will supply all drivers and supporting electrical equipment.
    a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure.
5. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
6. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
7. All luminaires, visors, and cross-arm assemblies shall withstand 150 mph winds and maintain luminaire aiming alignment.

8. Control cabinet to provide remote on-off control and monitoring of the lighting system. See Section 2.4 for further details.
9. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
    a. Integrated grounding via concrete encased electrode grounding system.
    b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780.The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.

D. Safety: All system components shall be UL Listed for the appropriate application.

2.3 ELECTRICAL

A. Electric Power Requirements for the Sports Lighting Equipment.
1. Electric Power: 480V, 3-phase.
2. Maximum Total Voltage Drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.

B. Energy Consumption: The kW consumption for the field lighting system shall be 124 kW or less.

2.4 STRUCTURAL PARAMETERS

A. Wind Loads: Poles and other support structures, brackets, arms, bases, anchorages and foundations shall be designed to resist wind loads as determined by ASCE 7-10 based on a Wind Speed (3 second gust) as indicated for the Project location in the Mapped Basic Wind Speeds for Risk Category and Exposure Category indicated. Luminaires, visors and crossarms shall be designed to resist wind loads while maintaining luminaire aiming alignment. All designs shall comply with the 2015 International Building Code (IBC).
1. Ultimate Wind Speed: 151 mph (3-second gust)
2. Nominal Wind Speed: 117 mph (3-second gust)
3. Risk Category: III
4. Exposure Category: C

B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2013 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).

C. Foundation Design: The foundation design shall be based on soil parameters as outlined in the geotechnical report. If a geotechnical report is not provided the foundation design shall be based on class 5 soils.

D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

2.5 CONTROL

A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.

B. Lighting contactor cabinet constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.

C. Remote Lighting Control System: System shall allow Owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in

advance. Manufacturer shall provide and maintain a two-way TCP/IP communications link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

1. The Owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute “early off” commands by phone. Scheduling tool shall be capable of setting curfew limits.
2. Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

D. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).

E. Management Tools: Provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS, Android and Blackberry devices.

F. Hours of Usage: Provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the Owner.

1. Cumulative Hours: Tracked to show the total hours used by the facility.
2. Report hours saved by using early off and push buttons by users.

G. Communication Costs: Include communications costs for operating the controls and monitoring system for a period of 25 years.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04.

B. Field Light Level Accountability:

1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 years.
2. The Contractor/Manufacturer shall be responsible for an additional inspection one year from the date of commissioning of the lighting system and will utilize the Owner’s light meter in the presence of the Owner.
3. The Contractor/Manufacturer will be held responsible for any and all changes needed to bring these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.

C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy the Owner.

3.2 SOIL QUALITY CONTROL

A. It shall be the Contractor’s responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner’s approval / payment for additional costs associated with:

1. Providing engineered foundation embedment design by a registered engineer in the State of Texas for soils other than specified soil conditions.
2. Additional materials required to achieve alternate foundation.
3. Excavation and removal of materials other than normal soils, such as rock caliche, etc.

3.3 DELIVERY TIMING

A. Delivery Timing Equipment On-Site: The equipment must be on-site 6-8 weeks from receipt of approved submittals and receipt of complete order information.

END OF SECTION 26 5668

SECTION 27 0000
COMMON COMMUNICATIONS REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. The requirements contained in this Section apply to all Sections of this Division.

1.02 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

B. Section Includes:
   1. Common terminology and requirements used throughout this Division.
   2. Identification and labeling.
   3. Firestop systems.
   4. Sleeves for raceways and cables.
   5. Grout.

1.03 PROJECT DESCRIPTION

A. The objective of this project is to provide complete communications systems installation including, but not limited to:
   1. Structured Cabling System:
      a. Optical Fiber Backbone Cabling
      b. Twisted Pair Copper Horizontal Data/Voice Cabling
      with attendant terminations, mounting equipment, power distribution, cable pathway and management systems, testing and other items/materials, as specified in drawings, these specifications, and contract documents.
   2. Intercommunications and Program (Paging) System: system head end equipment, amplifiers, system backbone cabling, speakers, and horizontal speaker cabling, with attendant terminations, mounting equipment, cable pathway and management systems, testing, and other items/materials as specified in drawings, these specifications, etc.
   3. Audio-Video Systems and Equipment: projectors, flat panel displays, sound reinforcement systems for assembly spaces, and sound reinforcement systems for classrooms, along with all attendant terminations, mounting equipment, routing/switching/amplification/control equipment, cabling, and cable pathway and management systems, test and other items/materials, as specified in drawings, these specifications, AV and theatrical specialty consultant's specifications, etc.
   4. Miscellaneous Communication Systems: elevator VoIP communicators with attendant terminations, mounting equipment, power supplies, etc. as specified in drawings, these specifications, etc.

1.04 DEFINITIONS

AHJ: Authority(ies) Having Jurisdiction.

Architect: The Architect of Record for the project, if any.

Business Day: Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.

CFCI: Contractor Furnished, Contractor Installed

Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, change orders, architect’s supplemental instructions, etc.

Contractor: The General Contractor and/or Construction Manager, and any contractor or subcontractor performing any low-voltage communications work in the project, whether proposing/working independently or subcontracted under the.

Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

Furnish: Deliver to the site in good condition.

Install: Install equipment furnished by others in complete working order.

OFCI: Owner Furnished, Contractor Installed

OFOI: Owner Furnished, Owner Installed

Provide: Furnish and install in complete working order.

1.05 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The work included in this division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Communications System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Communications Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this section of the specifications (or the remainder of the contract documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.06 DRAWINGS AND SPECIFICATIONS

A. The drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work.

B. The drawings and specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The drawings and specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, j-hooks, devices, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Communications equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Drawings are intended to show the approximate locations of equipment, materials, devices, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.

I. Where on the Drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word ‘typical’ is used, it shall mean that the work method or means indicated as typical for a condition shall be repeated in each instance where that condition occurs, whether indicated or not.

1.07 SUBSTITUTION PROCEDURES

A. Comply with provisions of Division 01 Section “Substitution Procedures”.

B. Substitution may be considered when a product becomes unavailable through no fault of the Contractor.

C. If an alternate material is proposed that is equal to or exceeds specified requirements, Contractor shall provide manufacturers’ specifications in writing for Owner approval prior to purchase and installation.

D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

E. Substitutions of material by the Contractor shall be in writing complete with written manufacturers’ specifications. The material substituted shall not void, alter or change manufacturers’ structured cabling system warranty.
   1. The Contractor shall provide a complete cabling infrastructure according to these written specifications and drawings.
   2. The Contractor shall respond to these changes with a complete material list, including pricing, labor, and taxes in writing presented to the Owner for approval.
   3. The Contractor shall not proceed with additional scope of work without a signed approval by the Owner.
   4. Owner will not pay for additional work performed by the Contractor without signed approval of these changes.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

G. The Owner will be the final judge of acceptability, with review by Engineer and the distribution of the acceptance by the Architect.
   1. No substitute shall be ordered, installed or utilized without the Architect’s prior written verification of acceptance from the Owner.

1.08 REFERENCES

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

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

C. Design, manufacture, test, and install data distribution systems per manufacturer's requirements and in accordance with NFPA 70, state codes, local codes, requirements of authorities having jurisdiction, and particularly the following specifications or standards:
   1. ANSI/TIA-568-C: Commercial Building Telecommunications Wiring Standard.
      a. ANSI/TIA-568-C.0: "Generic Telecommunications Cabling for Customer Premises", and its published addenda.
      b. ANSI/TIA-568-C.1: "Commercial Building Telecommunications Cabling Standard", and its published addenda.
      c. ANSI/TIA-568-C.2: "Balanced Twisted-Pair Telecommunication Cabling and Components Standard", and its published addenda.
      d. ANSI/TIA-568-C.3: "Optical Fiber Cabling Components Standard", and its published addenda.
   2. ANSI/TIA-569-B: "Commercial Building Standard for Telecommunications Pathways and Spaces", and its published addenda.
   3. ANSI/TIA-606-A: "Administration Standard for Commercial Telecommunications Infrastructure".
   4. ANSI/TIA-606-B: "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings", and its published addenda.
   5. ANSI-J-STD-607-B: "Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications", and its published addenda.
   6. ANSI/TIA-942: "Telecommunications Infrastructure Standard for Data Centers", and its published addenda.
   7. BICSI Telecommunications Distribution Methods Manual (TDMM)
   8. Local, county, state and federal regulations and codes in effect as of date of installation
   9. Equipment of foreign manufacture must meet U.S. codes and standards.

1.09 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Contractor shall supply all city, county, and state telecommunication cabling permits required by appropriate governing agency.
   2. Contractor shall be state-licensed and/or bonded as required for telecommunications/low voltage cabling systems.

B. Certifications
   1. Contractor shall submit an up-to-date and valid certification verifying qualifications of the Contractor and installers to perform the work specified herein at time of bid submission.
   2. Contractor shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
   3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.
      a. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
   4. Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.

5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document.
6. 80% shall have a minimum of three (3) years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
    a. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
7. Contractor shall submit evidence of compliance with these requirements prior to beginning work on the project.
8. Cabling installers shall be trained and certified by the cable manufacturer for telecommunication cabling installations and maintenance of said materials.
9. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

C. Administrative Requirements and Coordination requirements
1. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.
2. Coordinate installation work with other crafts (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc) to resolve procedures and installation placement for cable trays and cable bundle pathways.
    a. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
    b. Damage by Contractor to the craft work of others will be remedied at the Contractor's expense in a timely manner.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.
    a. Record agreements reached in meetings and distribute record to other participants, Owner and telecommunication consultant.
4. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment.
    a. Tasks shall be coordinated with Owner or his representative, owner's telecommunication utility provider(s) as applicable, and other trades' installation representatives.
5. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.

D. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.

E. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. Perform the following:
   1. Promptly notify the Architect in writing of any such difference.
   2. Obtain approval from Architect before proceeding with the Work.
   3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.

F. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
   1. Promptly notify the Architect in writing of any such difference.
   2. Obtain approval from Architect before proceeding with the Work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Contractor requirements:
   1. Be responsible for prompt material deliveries to meet contracted completion date.
   2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
   3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
   4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
   5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
   6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
      a. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
   7. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall supply a list of security requirements for Contractor to follow.

1.11 PROJECT/SITE CONDITIONS

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Contractor will remove burrs, dirt, and construction debris.
   1. If applicable, the Contractor will repair damaged finishes, including chips, scratches, and abrasions.

B. Contractor shall provide daily a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles.
   1. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

1.12 COORDINATION

A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also, where the description is general in nature, the exact sizes, duties, space arrangements, and other requirements must be obtained by reference to other portions of Contract Documents.

B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping" and in this Section.

F. Roof-Mounted Equipment: Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.13 MAINTENANCE

A. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty or Extended Warranty periods.

PART 2 PRODUCTS

2.01 IDENTIFICATION (LABELING) SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady
   2. Brother
   3. Dymo
   4. Hellerman-Tyton

2.02 FIRESTOP SYSTEMS

A. Refer to Division 07 Section “Firestopping” for additional requirements.

B. General:
   1. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
   2. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Manufacturers: Subject to compliance with requirements and with through-penetration firestop systems listed in Volume 2 of the UL Fire Resistance Directory, provide products by Specified Technologies, Inc. (STI) or Engineer approved equal.

D. Materials:
   1. Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
      a. STI SpecSeal Series SSS Sealant.

b. STI SpecSeal Series LCI Sealant.

2. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
   a. STI SpecSeal Series SSP Putty.
3. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
   a. STI SpecSeal Series SSB Pillows.
4. Fire-Rated Cable Grommet: Molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall. The following products are acceptable:
   a. STI EZ-Firestop Grommets.
5. Fire-Rated Cable Pathways: Device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
   a. STI EZ-PATH Fire Rated Pathway.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, with burrs removed and insulating bushing fittings on ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 STRUCTURED CABLING SYSTEM INSTALLERS

A. The Contractor shall be a certified Manufacturer's Authorized Installer and provide an end-to-end product warranty, adhere to the industry standard engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels in provisioning this project. Contractor must be Belden certified to furnish a Belden 25-year manufacturer's warranty.

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

C. Furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with the manufacturer/warranty contract agreement to support the lifetime system warranty requirements.

D. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the Owner. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

E. Establish a single point of contact (POC) with the Owner who will be responsible for reporting progress and updating the Owner's technical representative with issues that the Owner must address to facilitate the cabling system installation. POC shall provide daily written reports to the Owner's technical representative detailing progress. Requests for access to limited access or restricted areas shall be made three days prior to the required access. Information critical to the completion of the task or project shall be communicated to the Owner's technical representative as the requirement becomes known. Casual information shall be passed during the scheduled progress report.

F. Maintain the Owner's facility in a neat and orderly manner during the installation of the communications cabling system. The Owner's facilities shall be maintained in broom clean condition at the completion of work each day. At the completion of work in each area, perform a final cleaning of debris prior to moving the installation crew to the next work area.

G. All members of the installation team shall be certified by the Structured Cabling Manufacturer System Performance Warranty provider as having completed the necessary training to complete their part of the installation and capable of an installation that falls under manufacturer's guidelines necessary to obtain the Manufacturer's System Performance Warranty.

H. A BICSI RCDD shall supervise and approve all on-site work as a recognized member of the Contractor's installation team. All installation team members must demonstrate knowledge and compliance with all BICSI, TIA, UL, and NEC methods, standards and codes.

3.02 STRUCTURED CABLING SYSTEM INSTALLATION

A. Allowable Cable Bend Radius and Pull Tension:
   1. In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation.
   2. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
   3. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

B. Pull Strings:
   1. Horizontal cable requirements
      a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
      b. Pull string shall have a rated average breaking strength of 200 lbs.
      c. Data and video cables can be pulled in tandem with pull strings.
      d. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.

C. Conduit Fill: Reference manufacturer's Design Installation Guidelines manual, BICSI TDMM, and NEC. The most stringent applicable code or standard shall apply.

D. All material and equipment as provided should be the standard Commercial-Off-The-Shelf (COTS) products of a manufacturer engaged in the manufacturing of such products.
   1. All material and equipment shall be typical commercial designs that comply with the requirements specified.
   2. All material and equipment shall be readily available through manufacturers and/or distributors.

E. All equipment shall be standard catalogued items of the manufacturer and shall be supplied complete with any optional items required for proper installation.

F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

G. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.

H. Backward Compatibility: The provided solution shall be backward compatible with lower category ratings such that if higher category components are used with lower category components, the basic link and channel measures shall meet or exceed the lower channel's specified parameters.

I. Component Compliance: The provided solution's components shall each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent link and channel, regardless of the fact that tests for link and channel ultimately meet required specifications.

J. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

K. Owner's technical representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling to inspect the method of cable routing and support and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with the ANSI/TIA-568-C standards for jacket removal and pair untwist, compliance with manufacturer's minimum bend radius, and that cable ends are dressed neatly and orderly.

3.03 EXAMINATION

A. Field Measurements
   1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings.
   2. Coordinate fabrication schedule with construction progress to avoid delaying the work.

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

3.04 PREPARATION

A. Contractor's RCDD shall review, approve and stamp all Shop Drawings, Submittal Documents, Coordination Drawings and As Built Drawings.

B. Pre-Installation Inspection:
   1. Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.
   2. Visibly damaged goods are not acceptable and shall be replaced by the Contractor at no additional cost to the Owner.

3.05 LABELING

A. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

B. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.

C. Provide transparent plastic label holders, and 4-pair marked colored labels.

D. Install colored labels according to the type of field as per ANSI/TIA 606-A color code designations.

E. Use ANSI/TIA 606-A: “designation strip color-code guidelines for voice, data, cross- connect, riser, and backbone fields”

F. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Division 27 related devices should utilize a yellow identification marker on the ceiling grid.

3.06 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATION, ETC.

A. Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. Where minimum code requirements are exceeded in the Design, the Design shall govern.

F. Ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

G. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

3.07 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. Contractor shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Notify other trades in due time where openings of chases in new concrete or masonry are required. Set all concrete inserts and sleeves for work. Failing to do this, cut openings for work and patch same as required at own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Communications trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

3.08 SLEEVES AND PLATES

A. Provide and locate all sleeves and inserts required for work before the floors and walls are built, or be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all communications conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

3.09 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. Furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

3.10 FIRESTOPPING

A. Refer to Division 07 Section “Firestopping” for additional requirements.

B. Preparation:
1. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
4. Do not proceed until unsatisfactory conditions have been corrected.

C. Through-Penetration Firestop System Installation:
1. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design.
2. Comply with manufacturer’s instructions for installation of through-penetration firestop systems products.
3. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
4. Protect materials from damage on surfaces subjected to traffic.

D. Do not penetrate rated fire walls, ceilings or floors with conduit, cable, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the fire-rating of the assembly. Firestop all openings made in walls, chases, ceilings and floors. Patch all openings around conduit, wireway, etc., with appropriate type material to provide needed fire rating at fire walls, ceilings and floors. Fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

E. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

F. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24” between boxes is not maintained.

G. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.

H. Coordinate firestopping procedures and materials with General Contractor.

I. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

J. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.

K. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

L. Provide manufacturer recommended material for rated protection for any given barrier.

M. Laminate and permanently affix adjacent to chases the following information:
   1. Manufacturer of firestop system
   2. Date of installation/repair.
   3. Part and model numbers of system and all components
   4. Name and phone numbers of local distributor and manufacturer’s corporate headquarters

N. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

3.11 TESTING

A. Upon completion of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
   1. Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
   2. Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
   3. Cable/jack shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
      a. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
   4. Approved instruments, apparatus, services, and qualified personnel shall be utilized.
   5. If tests fail, Contractor shall correct as required to produce a legitimate passing test.
   6. Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.

7. If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

B. These specifications will be strictly enforced.
   1. The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
   2. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

C. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable.
   1. Without contractor’s prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Contractor’s expense (including respective connectors).
   2. With the Owner’s written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.

D. Testing is still required for non-compliant cabling.
   1. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to- ground.
   2. The test results must be within acceptable tolerances and shall be submitted with the Owner’s acceptance document.

E. Contractor will complete all work and documentation according to manufacturer guidelines to ensure manufacturer’s warranty remains in effect.
   1. Contractor shall obtain certificates from manufacturer attesting to warranty being in effect and include certificates with other deliverables due at the completion of the project.

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

3.12 SCAFFOLDING, RIGGING AND HOISTING

A. Furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

3.13 OPTION TO RELOCATE DEVICES

A. The location of voice and data outlets and other similar devices along with their associated connections may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to rough-in or installation.

3.14 CLEANING

A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.

B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

C. The Contractor will damp clean all surfaces prior to final acceptance by Owner.

D. After completion of all work and before final acceptance of the work, thoroughly clean all equipment and materials and remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

3.15 ACCEPTANCE

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

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as describe herein.

3.16 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

3.17 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

END OF SECTION

SECTION 27 0503
COMMUNICATIONS SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced per the specifications and/or schedules, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals.

B. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

C. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

D. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

E. The Engineer's review of shop drawings, schedules, product data or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

F. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

G. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:
   1. Raceways:
      a. Cable tray and each type of cable tray fitting.
      b. J-hook assembly.
   2. Structured Cabling:
      a. Backbone cabling.
      b. Horizontal cabling.
      c. Patch cords.
      d. Patch panels.

e. Racks and cable management.

3. Devices:
   a. Data/voice/video wallplates, each by type.
   b. Any special items not listed above.
4. Systems: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also, provide scale building layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.
   a. Data/Voice Network.
   b. Audio Video Systems and Equipment.
   c. Classroom Audio Video System.
   d. Intercommunications and Program Systems.
5. Miscellaneous
   a. Control panel assemblies.
   b. Non-standard junction/pullboxes.
   c. Floor plan and riser drawings that show the location of all communication devices and systems.
   d. Floor plan and riser drawings that show the location of all low-voltage devices and systems.

H. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, etc. and keys to alarm pull boxes, panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 MAINTENANCE AND OPERATION MANUALS

A. Upon Substantial Completion of the project, deliver to the Engineer (in addition to the required Shop Drawings) one complete copy and one digital copy of operation and maintenance instructions and parts lists for all equipment provided. At a minimum, these documents shall include the following:

1. The operation and maintenance document directory should provide easy access and be well organized and clearly identified.
2. Emergency information should be immediately available during emergencies and should include emergency and staff and/or agency notification procedures.
3. The maintenance and operating manual should contain the following information:
    a. General Building Information and Description.
    b. Technical Information:
        1) System description.
        2) Operating routines and procedures.
        3) Special procedures.
        4) Basic troubleshooting.
    c. Equipment Data Sheets:
        1) Operating and nameplate data.
        2) Warranty.
        3) Addresses and phone numbers indicating where parts may be purchased.
    d. Maintenance Program Information:
        1) Manufacturer's installation, operation, and maintenance instructions.
        2) Spare parts information.
        3) Preventative maintenance actions.
        4) Schedule of actions.
        5) Action description.
        6) History.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 27 0529
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other communications work.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.

D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition 2022.

E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

F. MFMA-4 - Metal Framing Standards Publication 2004.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

H. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. TIA-569 - Telecommunications Pathways and Spaces 2019e.

J. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 3000.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, and post-installed concrete/masonry anchors.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. TIA-569.
      b. NFPA 70.
      c. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Cable Supports: Suitable for cables to be supported, including but not limited to J-hooks, bridle rings, drive rings, and flexible harnesses/slings.
   1. Applications:
      a. Do not exceed 5 feet between cable supports.
      b. Provide supports with smooth, beveled edges and surface radius not less than minimum allowable bend radius of cables supported.
   2. Comply with TIA-569.
   3. Cable Supports Installed in Spaces Used for Environmental Air: Plenum rated; listed and labeled as complying with UL 2043, suitable for use in air-handling spaces.
   4. J-Hooks: Noncontinuous cabling support with removable top retainer clip.
      a. Material: Use galvanized steel, factory-painted steel, or stainless steel.
      b. Provide multitiered J-hooks where required to support multiple cabling systems.
   5. Bridle rings: Noncontinuous circular cabling support.
      a. Material: Use galvanized steel, painted steel, or stainless steel.
      b. Where required to preserve minimum allowable bend radius of supported cables, provide integral saddle with smooth, beveled edges and appropriate radius.

D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

E. Metal Channel/Strut Framing Systems:
   1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   2. Comply with MFMA-4.

F. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

G. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
   2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
   3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
   4. Hollow Stud Walls: Use toggle bolts.
   5. Steel: Use beam clamps, machine bolts, or welded threaded studs.
   6. Sheet Metal: Use sheet metal screws.
   7. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
      a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
      b. Comply with MFMA-4.
      c. Channel Material: Use galvanized steel.
   8. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
   1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
   2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

I. Secure fasteners in accordance with manufacturer's recommended torque settings.

J. Remove temporary supports.

END OF SECTION

SECTION 27 1100
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Backboards.
   2. Boxes, enclosures, and cabinets.
   3. Cable trays.
   4. Power strips.
   5. Uninterruptible Power Supplie

B. Related Requirements:
   1. Division 26 Section “Raceways and Boxes for Electrical Systems” for backbox and device boxes for communication outlets.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks, boxes, conduits, and accessories.
   3. Division 27 Section "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
   4. Division 27 Section "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

C. DEFINITIONS
   1. 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.
   2. BICSI: Building Industry Consulting Service International.
   3. RCDD: Registered communications distribution designer.
   4. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
   5. SBB: Telecommunications Secondary Bonding Busbar.
   6. PBB: Telecommunications Primary Bonding Busbar.
   7. UON: Unless otherwise noted

1.02 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include data indicating dimensions and finishes for each type of cable tray indicated.

D. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.

3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.
4. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to sides of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.03 INFORMATIONAL SUBMITTALS

A. Field quality control reports.

1.04 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section "Scope of the Communications Work" for additional information.

B. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

PART 2 PRODUCTS

2.01 BACKBOARDS

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

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

2.02 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Crouse-Hinds, an Eaton business.
   2. Hoffman; a brand of Pentair Equipment Protection.
   3. Hubbell Incorporated; Wiring Device-Kellems.
   4. O-Z/Gedney; a brand of Emerson Industrial Automation.
   5. Thomas & Betts Corporation; A Member of the ABB Group.

B. General Requirements for Boxes, Enclosures, and Cabinets:
   1. Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
   2. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
   3. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
   4. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
   5. Device Box Dimensions: 4 inches square by 2-1/8 inches deep, UON.

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

2.03 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Source Limitations: Obtain cable trays and components from single manufacturer.

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

D. 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.

2.04 LADDER CABLE TRAY

A. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
   1. B-Lline.
   2. Belden.
   3. Chatsworth Products, Inc. (CPI).

B. Description:
   1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
   2. Width: 12 inches unless otherwise indicated on Drawings.
   3. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
   4. Rung Spacing: 12 inches o.c.
   5. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
   6. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
   7. No portion of the rungs shall protrude below the bottom plane of side rails.
   8. Structural Performance of Each Rung: 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.
   9. Fitting Minimum Radius: 24 inches.
   10. Splicing Assemblies: Bolted type using serrated flange locknuts.
   11. 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 Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
      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: Epoxy-resin paint.
         1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
         2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
         3) Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

D. Basis-of-Design Chatsworth Components:

Description	Part Number
Chatsworth 12” Ladder Rack	10250-712
Wall to Rack Ladder Kit	11911-712
Wall Angle kit	11421-712
Wall Triangular Support	11312-12
Rack to Runway	10595-712
Cable Runway Elevation Kit	10506-702
Butt Splice	11301-701
Junction-Splice	11302-701
Cable Runway Radius drop	12100-712
End cap	10642-001

2.05 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.

2.06 POWER DISTRIBUTION UNITS AND POWER STRIPS

A. Comply with requirements in Division 27 Section "Communications Racks, Frames, and Enclosures."

B. Common Physical Characteristics:
   1. Rack mounting, with accessory brackets and/or flanges as noted.
   2. Housing: Aluminum.
   3. Finish: Black powder coat to match rack hardware.

C. Vertical PDUs
   1. Product: Subject to requirements, provide Chatsworth #E0-1002-C or Engineer approved equal. Provide PDU offset brackets for each PDU installed.
   2. Circuit and Outlet Configuration
      a. Inlet cord: 30A, 120V AC NEMA L5-30P.
      b. Two (2) 20A 5kAIC circuit breakers
      c. Twenty-four (24) 20A, 120V AC, NEMA 5-20R receptacles in two (2) breaker groups.
   3. Listings and labeling
   4. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
      a. Comply with UL/CUL/IEC 62368.
      b. Breaker(s) listed UL 489.

2.07 UNINTERRUPTIBLE POWER SUPPLIES

A. Common Physical Characteristics:
   1. Rack mounting, with accessory brackets or flanges as needed for mounting. Refer to Division 27 Section "Communications Racks, Frames, and Enclosures" for rack product data
   2. Steel or aluminum enclosure with black powdercoat finish

B. Uninterruptible Power Supply, 3kVA Size w/ Network Management Card
   1. Product: Subject to requirements, provide APC #SMT3000RM2UC or Engineer approved equal.

2. Network Management Card w/ Environmental Monitoring: Subject to requirements provide APC #AP9641 UPS Network Management Card 3 with Environmental Monitoring. Provide 1 card for each UPS.
3. Circuit and Outlet Configuration:
   a. Inlet cord: 30A, 120V AC NEMA L5-30P.
   b. Two (2) 20A, 120V AC, NEMA 5-20R receptacles
   c. Six (6) 15A, 120V AC, NEMA 5-15R receptacles.
4. Electrical Characteristics:
   a. UPS Topology: Line Interactive
   b. Output Characteristics: Sine Wave, 50/60 Hz +/- 3 Hz synchronized to mains
   c. Max Configurable Power: 2700 W, 2880 VA
   d. Transfer Time: 6ms typical, 10ms maximum
5. Physical Characteristics:
   a. 19-inch rack mountable, 2 RU
   b. Weight: 97.62 lb
6. Warranty: Provide 3-yr extended warranty service pack, APC #WBEXTWAR3YR-SP-04.

PART 3 EXECUTION

3.01 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 Division 26 Section "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.02 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 layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

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

G. Vertical PDUs:
   1. Provide two (2) vertical PDUs in MDF.
   2. Provide one (1) vertical PDU in each IDF.
   3. Mount units on back of rack with offset bracket.

H. Uninterruptible Power Supplies with Network Management Cards (UPS):Provide two (2) 3kVA size Uninterruptible Power Supplies with Network Management Card in MDF.
   1. Provide two (2) 3kVA size UPSes in MDF.
   2. Provide one (1) 3kVA size UPS in each IDF.
   3. Mount units at bottom of rack.

I. Backboards:
   1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
   2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards.
   3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.03 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. 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.

G. 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.

H. Support tray assembly to prevent twisting from eccentric loading.

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

J. 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.

K. 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.

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

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

N. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07 Section "Penetration Firestopping."

O. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

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

Q. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

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

3.04 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26 Section "Grounding and Bonding."

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

C. 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.

D. 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."

3.05 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 every 18 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.

3.06 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section “Common Communications Requirements.”

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

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

3.07 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.

3.08 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 paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 1116
COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 19-inch, 2-post network equipment racks.
   2. 19-inch, wall-mounted enclosed cabinet network equipment racks.
   3. Vertical cable management assemblies.
   4. Horizontal cable management assemblies.
   5. Cross-connect fields / patch panels.
   6. Grounding.
   7. Labeling.

B. Related Requirements:
   1. Division 26 Section "Grounding and Bonding" for PBBs and SBBs.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks and conduit.
   3. Division 27 Section "Communications Equipment Room Fittings" for backboards, cable trays, cable tray accessories, power strips, UPSes, and accessories.
   4. Division 27 Section "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
   5. Division 27 Section "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
   1. RCDD: Registered communications distribution designer, a BICSI credential.

B. LAN: Local area network.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
   1. Main Cross-Connect (MC):Central cross-connect for backbone cabling to the ICs and HCs. Frequently co-located with the EF.
   2. Horizontal Cross-Connect (HC): Cross-connect facility providing backbone cabling termination and distribution for Horizontal Cabling.
   3. Intermediate Cross-Connect (IC): Cross-connect facility providing intermediate-level backbone cabling distribution.

D. Entry-Facility (EF): The facility where service cabling from telecom access providers or campus OSP distribution terminates, also known as the Demarcation Point or Demarc.

E. Equipment Room (ER): An environmentally controlled centralized space for telecommunications equipment. Frequently co-located with the MC or IC.

F. PBB: Primary Bonding Busbar.

G. SBB: Secondary Bonding Busbar.

H. Telecommunications Enclosure (TE): A self-contained enclosure that provides a secure location for connection between backbone and horizontal infrastructure.

I. Telecommunications Room (TR): A room (or space) that provides an environmentally suitable and secure location for the connection between backbone and horizontal infrastructure.

1.03 CABINETS, RACKS, FRAMES, AND ENCLOSURES DESCRIPTION:

A. The ER (MDF) and TRs (IDFs) shall house racks, cross-connect fields for backbone and horizontal cabling, and required cable routing hardware.

B. The ER (MDF) shall be equipped with 2-post 19-inch racks as shown on drawings.

C. Each typical TR (IDF) shall be equipped with 2-post 19-inch racks as shown on drawings.

D. Each TE (Wall-rack IDF) shall be installed within a wall-mounted enclosed cabinet.

E. Racks and cabinets shall be placed as shown on the drawings, and/or located in a manner that will allow a minimum of 3 feet of clearance from the front and 3 feet from the rear mounting surfaces and on one side.

F. Vertical cable management shall be provided along both sides of all two-post racks. Refer to drawings for layouts.

G. Horizontal cable management shall be provided within all equipment racks.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
   2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

D. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
   3. Grounding: Indicate location of each bonding busbar on plans. Provide a mounting detail showing standoff insulators and wall-mounting brackets.

1.05 INFORMATIONAL SUBMITTALS

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

1.06 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

B. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
   2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. 19-inch rack width shall comply with EIA/ECIA 310-E, 19-inch nominal panel width with an opening of 17.72-inches between rails and mounting hardware

2.02 MANUFACTURERS

A. Subject to requirements, provide products manufactured by the following:
   1. Chatsworth Products, Inc. (CPI)
   2. Commscope
   3. NVent-Hoffman
   4. Others by Prior Engineer Approval.

2.03 19-INCH, TWO-POST NETWORK EQUIPMENT RACKS

A. Description: Freestanding, modular 19-Inch two-post racks with threaded (#12-24) rails designed for mounting telecommunications equipment.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Chatsworth Products, Inc. (CPI) #55053-703.

C. Appearance and Finishes:
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black.
   2. Rack Units Marked and Numbered in contrasting color.

D. Physical Characteristics:
   1. Overall Dimensions: 84"H x 20.3"W x 15"D (including mounting flanges).
   2. Upright Channel Depth: 3inches
   3. Load Rating: 1000 lb. of equipment.
   4. Equipment space: 45RU
   5. Universal hole pattern, 5/8" - 5/8" - 1/2" vertical spacing.
   6. Grounding/bonding lug inside side channel with prepared bare metal attachment point.
   7. Base shall have a minimum of four mounting holes for permanent attachment to floor.
   8. Top shall have provisions for attaching to cable tray or ceiling.
   9. Self-leveling.

2.04 19-INCH, WALL-MOUNTED ENCLOSED CABINET NETWORK EQUIPMENT RACKS

A. Description: Wall-mounted, floor-supported, enclosed modular 19-Inch racks with square hole rails designed for mounting telecommunications equipment, locking front door, and swing-out rear access.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Chatsworth Products, Inc. (CPI) #13492-772

C. Appearance and Finishes:
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black.
   2. Rack Units Marked and Numbered in contrasting color.

D. Physical Characteristics:
   1. Overall Dimensions: 72"H x 27.3"W x 24"D (including mounting flanges).
   2. Steel construction
   3. Load Rating: 1000 lb. of equipment, open or closed.
   4. Equipment space: 40RU
   5. Universal hole pattern, 5/8" - 5/8" - 1/2" vertical spacing.
   6. Prepared grounding/bonding provisions inside enclosure.
   7. Wheeled base for support of equipment load.

2.05 VERTICAL CABLE MANAGEMENT:

A. Description: 10" wide double-sided metal-channel vertical cable managers with front door.

B. Approved Products: Subject to compliance with requirements, provide:
   1. NVent-Hoffman #DV10D7.

C. Physical Characteristics:Metal, with integral wire retaining fingers.
   1. 10-inch wide aluminum channel (all managers on project to be 10-inch).
   2. Flexible composite cable management fingers.
   3. Double-sided finger-type cable management configuration type.
   4. Front door with access from right or left and 180 degree swing.

D. Appearance and Finishes:Baked-polyester powder coat finish.
   1. Finish: Manufacturer's standard, baked-polyester powder coat. Color: Black

E. All two-post equipment racks shall be augmented with vertical cable management hardware, both front and rear, to properly dress cables and patch cords.

2.06 HORIZONTAL CABLE MANAGEMENT:

A. Description: 2RU double-sided composite horizontal cable managers with front and back covers.

B. Approved Products: Subject to compliance with requirements, provide:
   1. NVent-Hoffman #DCHD2.

C. Physical Characteristics
   1. Composite construction.
   2. Flexible composite cable management fingers.
   3. Removable hinged covers open to both top and bottom.
   4. Pass-thru holes for routing cable between front and back of rack.

D. All equipment racks shall be augmented with horizontal cable management hardware, both front and rear, to properly dress cables and patch cords.

E. Horizontal cable management shall be provided between each network switch and patch panel.

2.07 CATEGORY 6 AND CATEGORY 6A PATCH PANELS:

A. Description: Termination for copper horizontal cabling shall consist of Category 6 patch panels with the following characteristics:
   1. Circuit board type terminal construction.
   2. Medium density (1RU, 24-port and 2RU, 48 port) flat front configuration
   3. Data patch panels: 48-port.
   4. Other applications patch panels: 24-port.
   5. Terminated in T568B configuration.

B. Category 6 Products: Subject to compliance with requirements, provide:
   1. Commscope #UNP-6-DM-1U-24 (760180042) (1RU 24-Port)
   2. Commscope #UNP-6-DM-2U-48 (760180059) (2RU 48-Port)

C. Category 6A Products: Subject to compliance with requirements, provide:
   1. Commscope #UNP-6A-DM-1U-24 (760162800) (1RU 24-Port)
   2. Commscope #UNP-6A-DM-2U-48 (760162818) (2RU 48-Port)

D. Each panel shall be black in color with individual ports numbered sequentially, from left to right, top to bottom. All ports shall be labeled 01-48, below the port.

E. An additional label area shall be provided immediately above each port to allow for room number labeling at each port.

F. Each port in the panel shall have 8 conductors present configured to 8P8C standard pin-out T568B.

G. A set of 48 ports shall be given a panel letter, starting with panel A.

H. The panel letter shall be labeled on the left of flat patch panels in large font, with the closet name listed above it.

I. A rack number is not necessary. Panels on additional racks shall continue panel lettering of previous rack.

J. A separate patch panel shall be provided for IP based video surveillance cameras.

K. Separate Category 6A patch panels shall be provided for wireless access point drops.

2.08 FIBER OPTIC PATCH PANELS

A. Description: Rack- and/or wall- mounted enclosures providing protection for terminated backbone fiber and cross-connection cabling.

B. Approved Products: Subject to compliance with requirements, provide:
   1. Commscope #EPX-2U-PNL-ENC-FX (760251047) (2U Fixed Enclosure)
   2. Commscope #EPX-4U-PNL-ENC (760251049) (4U Sliding Enclosure)
   3. Commscope #WB2-EMT-BK-2P-PNL (760248905) (Wall Enclosure)

C. Physical Characteristics:
   1. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a wrinkled black powder coat for durability. All fasteners shall be black-chromate to match the housing.
   2. The unit shall have guides that allow a transition and segregation point for jumpers exiting the sides of the housing.
   3. 4RU panels shall be sliding configuration tray with a metal door.
   4. 2RU panels shall have a fixed tray with a metal door.
   5. Wall-mount panels shall have (2) separate compartments, one for backbone terminations and one for patch cables. Each compartment shall have a door.

D. Functional Characteristics:
   1. Each connector shall be held by a duplex coupler snap-in adapter plate. Adapter plates shall be installed into rack-mount fiber optic enclosure. Refer to
   2. Enclosures shall be designed to protect against bend radius violations.
   3. Enclosures shall ensure that cable routing paths for all fibers are clear and cable congestion is minimized.
   4. The unit shall be modular with separate splicing, connector and jumper management housings available.
   5. The rack-mounted housings shall meet the requirements of TIA/EIA-568-A and UL V-0.
   6. The connector housings shall have a labeling scheme that complies with TIA/EIA-606.

2.09 COMMUNICATIONS TERMINATION BLOCKS

A. Termination block fields shall be mounted on 4’ x 8’ x .75” virgin fire retardant plywood, unless otherwise noted in Drawings, and shall be on the opposite side of the room from the room entrance. Backbone termination fields shall be mounted to the left of the horizontal voice fields. Conduits with 4” minimum diameter shall be used in all telecommunications rooms. Conduits for data backbone shall be located adjacent to the racks and conduits for voice shall be located adjacent to the voice termination fields. Provide required ladder and wall-mount management rings to properly support and dress cables from conduits to racks and frames.

2.10 LABELING

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

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

PART 3 EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

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

C. Install all systems in accordance with manufacturer's printed instructions.

D. Frames shall be oriented so that backbone frames are located on the left and horizontal frames are located on the right of the termination field when facing the frame assembly.

E. Horizontal data terminations shall be contained in 19" x 84" racks. All equipment racks shall be augmented with horizontal and vertical cable management hardware, both front and rear, to properly dress horizontal cables and patch cables.

F. Each patch panel shall be separated vertically on the rack by a 1U (for 1U patch panels) or 2U (for 2U patch panels) horizontal cable management panel.

G. Patch panels and fiber enclosures shall be mounted in floor standing equipment racks or cabinets. Installation should follow the recommendations listed in ANSI/TIA-942 "Telecommunications Infrastructure Standard for Data Centers" specification.

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

I. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
   1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
   4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

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

K. Floor-mounted racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If the mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6 inches to the wall to allow room for vertical management. Where there is more than one rack, the racks shall be ganged with vertical management hardware to provide cable management. Ganged rack frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly.

3.02 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with NECA/BICSI 607.

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

D. Locate SBB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind SBB. Connect SBB with a minimum No. 2 AWG grounding electrode conductor from SBB to suitable electrical building ground. Connect rack ground bar kit to near SBB or the PBB.
   1. Bond the shield of shielded cable to patch panel, and bond patch panel to SBB or PBB.

3.03 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA/EIA-606-A.

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

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.

D. Label patch panels in each telecommunications room to match those on the corresponding data outlets. All labels shall correspond to as-builts and to final test reports.

E. Labels shall be machine printed. Font type shall be 3/16 inch in height.

F. Labeling system shall clearly identify all components of the system: racks, cables, panels, and outlets.

G. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

H. The following nomenclature shall be used when labeling data outlets:
   1. Example Data Port: M-A01
      a. M – ‘M’ for MDF, ‘I1’ for IDF#1, ‘I2’ for IDF#2, etc.
      b. A – Data cables patch panel origin
      c. 01 – Outlet cable number

I. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

J. All labels shall incorporate room numbers from the final Owner’s room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

END OF SECTION

SECTION 27 1323
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 9/125 micrometer single-mode optical fiber cable, plenum rated (OS2).
   2. Optical fiber cable connecting hardware, patch panels, and cross-connects.
   3. Cabling identification products.

B. Related Requirements:
   1. Division 26 Section "Grounding and Bonding" for Grounding and Bonding Busbars.
   2. Division 26 Section "Pathways for Communications Systems" for j-hooks and conduit.
   3. Division 27 Section "Communications Racks, Frames, and Enclosures" for fiber patch enclosures.

1.02 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
   1. RCDD: Registered Communications Distribution Designer, a BICSI credential.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
   1. Main Cross-Connect (MC):Central cross-connect for backbone cabling to the ICs and HCs. Frequently co-located with the EF.
   2. Horizontal Cross-Connect (HC): Cross-connect facility providing backbone cabling termination and distribution for Horizontal Cabling.

C. Entry-Facility (EF): The facility where service cabling from telecom access providers or campus OSP distribution terminates, also known as the Demarcation Point or Demarc.

D. Equipment Room (ER): An environmentally controlled centralized space for telecommunications equipment. Frequently co-located with the MC or IC.

E. Telecommunications Enclosure (TE): A self-contained enclosure that provides a secure location for connection between backbone and horizontal infrastructure.

F. Telecommunications Room (TR): A room (or space) that provides an environmentally suitable and secure location for the connection between backbone and horizontal infrastructure.

1.03 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Provide OSP fiber cabling from Elementary School to new High School Entrance Facility (EF). Cabling shall be OS2 single-mode OSP fiber cable with non-metallic armor jacket.

B. Fiber cabling from EF to MC shall be OS2 single-mode indoor optical fiber cable with interlocking armored plenum outer jacket.

C. Intrabuilding Backbone cabling from MC to each HC shall be OS2 single-mode indoor (or hybrid indoor/outdoor, as appropriate) optical fiber cable with interlocking armored plenum outer jacket.

D. Backbone cabling from MC to each outbuilding HC shall be OS2 single-mode hybrid indoor/outdoor optical fiber cable with non-metallic plenum outer jacket.

E. Optical fiber backbone cabling system shall provide connections between the communications MC and the EF, HC(s), and ERs in the telecommunications cabling system structure in a star topology.

F. Cabling system consists of backbone cables, cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection and/or backbone-to-equipment interconnection.

G. Backbone cabling cross-connects may be located in TRs, TEs, ERs and/or at EFs. Bridged taps and splitters shall not be used as part of backbone cabling.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.

D. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Plan and Elevation views, including the following:
      a. Building floor plan(s) showing:
         1) Telecommunication room/space locations.
         2) Telecommunications pathways locations.
      b. Enlarged plans of each ER and TR showing equipment rack layout and rack IDs.
      c. Rack elevations showing physical location and IDs of cross-connects and patch panels.
   4. Backbone cabling system schematic, indicating cable types and counts to be provided for each connection.

E. Optical fiber cable testing plan.

1.05 INFORMATIONAL SUBMITTALS

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

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.06 CLOSEOUT SUBMITTALS

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

B. Field test and observation reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to a compliance with performance requirements of the installed system.
   1. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment name, manufacturer, model number, and last calibration date will also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test.
   2. When repairs and re-tests are performed, the problem and corrective action taken shall be noted, and both the failed and passed test data shall be submitted.

1.07 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

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

1. Installer, as a business entity, shall be an authorized distributor and designated representative of the equipment manufacturer, with full extended warranty privileges. The Installer shall have been actively engaged in the business of selling, installing, and servicing commercial building commercial cable systems for a period of at least 5 years.
   a. Recently formed companies are acceptable only if specific pre-approval is requested and granted by the Architect/Engineer, based on experience of key personnel, current and complete projects, and all licensing requirements are met 10 working days prior to the contract proposal date.
2. Installer shall have an office within 150 miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner's representatives in the proper operation of the system, and to provide service throughout the warranty period. The contractor shall be capable of dispatching technicians to repair a system within six hours of a service request.
3. Installer shall employ factory-trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Installer's submittal.
4. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
5. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
6. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
7. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the Owner.

1.08 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 fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. 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.

1.09 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.

1.10 COORDINATION

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

1.11 WARRANTY

A. The selected system installer shall be factory certified by the manufacturer and shall provide an end-to-end performance warranty of not less than twenty-five (25) years for modifications to the system. The cabling contractor shall provide certification documentation. The performance warranty shall be issued by the manufacturer.

B. The warranty shall cover all fiber optic cabling installed under this contract, with testing in accordance with the manufacturer's requirements.
   1. Single-mode fiber shall be tested in accordance with ANSI/TIA/EIA-526-7 Method B.

C. The warranty shall stipulate that all products used in this installation meet the prescribed mechanical and transmission specifications for such products as described in ISO/IEC 11801, ANSI/TIA/EIA-568-A, or EN 50173. Quality and workmanship evaluation shall be solely by the Owner and designated representatives.
   1. Upon completion of the project, the Owner’s technical representative will perform a final inspection of the installed cabling system with the Contractor’s project foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the Drawings, and that the installation meets the aesthetic expectations of the customer.
   2. Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If significant discrepancies are found, the contractor will be notified for resolution.
   3. During the three-week period between final inspection and delivery of the test and as-built documentation, the customer will activate the cabling system. Owner will validate operation of the cabling system during this period.
   4. Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as-built documentation, and successful performance of the system for a two-week period will constitute acceptance of the system.

PART 2 PRODUCTS

2.01 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. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

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

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

2.02 MANUFACTURERS

A. Subject to requirements, provide products manufactured by the following:
   1. CommScope
   2. Others by Prior Engineer Approval.

2.03 9/125 MICROMETER, SINGLE-MODE, INDOOR PLENUM OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered optical fiber cable with plenum rated jacket.

B. Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-DZ-8W-FSUYL (760127803)

C. Part numbers provided above are for 12-strand cable; refer to structured cabling riser for strand counts. Provide Manufacturer's direct replacement if the specified product is discontinued.

D. 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.

E. Construction:
   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.
   4. Armored cable shall be aluminum armored type.

F. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.

G. 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, Armored (Conductive): Type OFCP

2.04 9/125 MICROMETER, SINGLE-MODE, HYBRID INDOOR/OUTDOOR PLENUM OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, tight buffered interlocking armor optical fiber cable with plenum-rated indoor/outdoor hybrid jacket.

B. Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-OZ-8W-FSUBK (760134924)

C. Non-Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #P-012-OD-8W-FSUBK (760037192)

D. Inner Duct: For each non-armored cable, provide 1" innerduct throughout the entire run, rated for the space in which it is installed.

E. Part numbers provided above are for 6-strand cable; refer to structured cabling riser for strand counts. Provide Manufacturer's direct replacement if the specified product is discontinued.

F. 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.

G. Construction
   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.
   4. Non-Armored cable shall contain no metallic elements.

H. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.

I. 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 (Non-conductive): Type OFNP

2.05 9/125 MICROMETER, SINGLE-MODE, OUTSIDE PLANT OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, all-dielectric, gel-free loose-tube optical fiber cable rated for burial applications.

B. Non-Armored Cable: Subject to compliance with requirements, provide:
   1. Commscope #D-024-LN-8W-F12NS (760053850)

C. Part numbers provided above are for 24-strand cable; refer to structured cabling riser for strand counts. Provide Manufacturer's direct replacement if the specified product is discontinued.

D. 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.

E. Construction
   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.
   4. Cable shall contain no metallic elements.

F. Maximum Attenuation: 0.7 dB/km at 1310 nm; 0.7 dB/km at 1550 nm.

2.06 OPTICAL FIBER CABLE HARDWARE

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

B. Jack Assemblies (Commscope):
   1. Adapter panel with (6) ganged female-female duplex LC connectors.
   2. Designed to install in Commscope LGX/1000 format patch panels.
   3. Approved Products:
      a. Commscope #760067165 or equivalent.

C. Plugs and Plug Assemblies (Commscope):
   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.
   4. Approved Products:
      a. Commscope LC Single-Mode #SFC-LCF-09-8X (760117895).

D. Connector Type: Type LC complying with TIA-604-10.

E. 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, plus spares and blank positions adequate to suit specified expansion criteria.

F. Patch Cords:
   1. Factory-made, fiber optic cable assemblies using duplex cable.
   2. Patch cord assemblies shall be LC to LC, 3-meter length.

2.07 OUTSIDE PLANT SPLICE CLOSURES

A. Description: O-ring sealed IP68 splice closure device with trays for 144 single-fusion splices, rated for below-grade installation.

B. Provide OSP splice closures where splices are necessary in OSP fiber due to run length. Closure to be installed in below grade handhole.

C. Products: Subject to requirements, provide one of the following:
   1. Amphenol #FODC-A
   2. Commscope #FOSC-MSC series equal.
      or Equal by prior approval from Owner and Engineer.

2.08 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

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

2.09 INNER DUCT

A. Description: Corrugated non-metallic flexible raceway for separation and protection of fiber optic cabling.

B. Corrugated tubing, size as noted. Color Orange U.O.N.

C. Factory pre-installed pull tape.

D. Approved manufacturers:
   1. Carlon
   2. Dura-line

E. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 910, and NFPA 70, rated for use in environmental air handling plenum.

2.10 IDENTIFICATION PRODUCTS

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

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test single mode optical fiber cables according to TIA-526-7B and TIA-568-C.3

C. Cable will be considered defective if it does not pass tests and inspections and must be replaced.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 ENTRANCE FACILITIES

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

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements of demarcation point, cabinets, and racks specified in Division 27 Section “Communications Racks, Frames, and Enclosures.”

B. Comply with Division 26 Section “Pathways for Communications Systems.”

C. Drawings indicate general arrangement of pathways and fittings.

3.03 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for pathways specified in Division 26 Section "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. 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.

D. Non-armored fiber optic cabling shall be installed in inner duct, u.o.n.

3.04 INSTALLATION OF PREMISES 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.
   12. Backbone cables shall be installed separately from horizontal distribution cables. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
   13. Where cables are installed in air return plenums, the backbone cable shall be installed in conduit to provide protection of cable. Backbone cables shall be installed in separate conduits from horizontal distribution cables.
   14. Cable shall be installed in innerduct from fiber patch panels to plenum entrances. Innerduct shall not be installed in plenum ceilings unless it is UL approved plenum rated. Plenum rated cable shall be installed in conduit or UL approved plenum rated innerduct in all plenum ceilings.
   15. Inside plant cables above four fibers shall support a minimum bend radius of 10 times the cable diameter under no tensile load and 20 times the cable diameter under tensile loading to the cable’s rated limit.

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.
   3. Where backbone cables and distribution cables are installed in a cable tray or j-hooks, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

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

E. Terminations: Terminations shall be performed by manufacturer-trained and certified technicians. Terminations shall be made in a controlled environment. Contractor may choose to have cables assembled off-site, although testing must be completed with the cable in its final installed condition.

F. Warning Tags: At each location where fiber cable is exposed to human intrusion, it shall be clearly marked with waring tags. These tags shall be yellow or orange in color and shall contain the warning: “CAUTION FIBER OPTIC CABLE”. The text shall be permanent, black, block characters, and at least 3/16-inch high. A warning tag shall be permanently affixed to each exposed cable or bundle of cables at intervals of not less than five (5) feet. Any section of exposed cable that is less than five (5) feet in length shall have at least one warning tag affixed to it.

3.05 INSTALLATION OF SITE-TO-SITE OPTICAL FIBER BACKBONE CABLES

A. Provide OSP fiber from Elementary School campus to High School as indicated on structured cabling riser.

B. General installation requirements are to be the same as for premises optical fiber except for the following:
   1. Fiber is to be installed in buried conduit for its entire length.
   2. Provide handholes to facilitate access and cable installation at nominal intervals of 250ft (not to exceed 300ft).
   3. Installation shall utilize the minimum quantity of splices possible. If splices are required, they shall be performed using dome type splice closures as specified herein, mounted in below-grade handholes.

C. Site-to-Site fiber shall terminate at each end in a wall-mount indoor enclosure as specified in section 27 1116 Racks, Frames, and Enclosures.

3.06 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section “Common Communications Requirements.”

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

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

3.07 GROUNDING

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

B. 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. 2 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

C. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

D. Bond conductive cable armor to the telecom grounding system per ANSI-J-STD-607 and NEC.

3.08 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in the OSDM Communication and Network Systems Telecommunications Standards. The identification scheme will be provided by the Owner.

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, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

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. Exposed Cables and Cables in Cable Trays and J-hooks: Label each cable at intervals not exceeding 15 feet.
   3. Label each unit and field within distribution racks and frames.
   4. 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.
   5. Labeling shall note cable type, run designation, “Tx” for transmit fiber connectors, and “Rx” for the receive fiber connectors.
   6. Cable labels shall not be obscured from view.

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/EIA 606-A, for the following:
   1. Flexible vinyl or polyester that flexes as cables are bent.
   2. Labels shall be machine printed. Type shall be 3/16 inch in height.

F. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

G. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

H. All labels shall incorporate room numbers from the final Owner’s room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative

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. Testing device for fiber optic cables shall be a high quality OTDR (Optical Time-Domain Reflectometer) equipped with a printer. The printed data shall show, in addition to any summary information, the complete test trace and all relevant scale settings. The OTDR must have the capability to take measurements from bare fiber strands as well as SC connector terminations.
    c. All fiber optic cable shall be tested on the reel before installation to ensure that is meets the specifications outlined herein.
    d. After installation, test each fiber strand in accordance with the EIA 455-171 Method D procedures (bi-directional testing) at both 850 and 1300 nm for multimode and 1310nm and 1550nm for single-mode. A form shall be completed for each cable showing data recorded for each strand including length, total segment (end-to-end) loss (dB) and connector losses (dB) at each end. In addition, the printed data strip for each strand shall be attached to the form. Patch cables shall also be tested.
    e. Single-mode fibers shall have a maximum attenuation of 1.0 dB/km at 1310 nm and 1.0 db/km at 1550 nm
    f. Multimode fibers shall have a maximum attenuation of 3.5 dB/km at 850 nm and 1.5 dB/km at 1300 nm.
    g. Acceptable fiber optic connector loss shall not exceed 0.75 dB per mated pair. The Contractor is responsible for obtaining minimum loss in fiber connections and polishing per manufacturer's specifications.

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. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.

G. OTDR shots shall be provided for each strand of fiber completely installed and terminated.

H. Prepare test and inspection reports.

3.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened, protective containers and packaging, with labels clearly identifying product name and manufacturer.
    1. Store materials in secure, clean, and dry area indoors in accordance with manufacturer's instructions.
    2. Protect materials and finish from damage and moisture during handling and installation.

END OF SECTION

SECTION 27 1513
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

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

1.02 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. EMI: Electromagnetic interference.

D. FTP: Shielded twisted pair.

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

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

G. IDC: Insulation displacement connector.

H. LAN: Local area network.

I. Jack: Commonly called an "outlet," it is the fixed, female connector.

J. Plug: Commonly called a "connector," it is the removable, male telecommunications connector.

K. RCDD: Registered Communications Distribution Designer.

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

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

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

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

P. UTP: Unscreened (unshielded) twisted pair.

1.03 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cabling for data circuits shall be Category 6, 24 AWG, 4-pair UTP, UL/NEC CMP rated and independently verified for compliance.

B. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," 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. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

C. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

D. The maximum allowable horizontal cable length is 275 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.

E. The horizontal cabling shall extend from each designated data outlet to the nearest IDF or the MDF in a star topology.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data: For each type of product.

D. Shop Drawings: Reviewed and stamped by RCDD.
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration Drawings and printouts.
   3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
      a. Telecommunications rooms plans and elevations.
      b. Telecommunications pathways.
      c. Telecommunications system access points.
      d. Telecommunications grounding system.
      e. Telecommunications conductor drop locations.
      f. Typical telecommunications details.
      g. Mechanical, electrical, and plumbing systems.

E. Twisted pair cable testing plan.

1.05 INFORMATIONAL SUBMITTALS

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

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

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

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

C. Field test and observation reports from a qualified independent inspecting and testing agency indicating and interpreting test results relative to a compliance with performance requirements of the installed system.
   1. Test data within each section shall be presented in the sequence listed in the administration records. The test equipment name, manufacturer, model number, and last calibration date will also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test.

2. When repairs and re-tests are performed, the problem and corrective action taken shall be noted, and both the failed and passed test data shall be submitted.

1.07 QUALITY ASSURANCE

A. Refer to Quality Assurance information in Division 27 Section “Scope of the Communications Work” for additional information.

B. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Installer, as a business entity, shall be an authorized distributor and designated representative of the equipment manufacturer, with full extended warranty privileges. The Installer shall have been actively engaged in the business of selling, installing, and servicing commercial building commercial cable systems for a period of at least 5 years.
      a. Recently formed companies are acceptable only if specific pre-approval is requested and granted by the Architect/Engineer, based on experience of key personnel, current and complete projects, and all licensing requirements are met 10 working days prior to the contract proposal date.
   2. Installer shall have an office within 150 miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner’s representatives in the proper operation of the system, and to provide service throughout the warranty period. The contractor shall be capable of dispatching technicians to repair a system within six hours of a service request.
   3. Installer shall employ factory-trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Installer’s submittal.
   4. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
   5. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
   6. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
   7. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer’s warranty requirements, including test results, and to apply for said warranty on behalf of the Owner.

1.08 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.

1.09 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.

1.10 COORDINATION

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

1.11 WARRANTY

A. The selected system installer shall be factory certified by the manufacturer and shall provide an end-to-end performance warranty of not less than twenty-five (25) years for modifications to the system. The cabling contractor shall provide certification documentation. The performance warranty shall be issued by the manufacturer and shall warrant that all Category 6+ cable links have been tested bi-directionally (end-to-end) using a Level 2 tester, per TSB-67, and that all test results conform to the most current TIA/EIA-568-A and/or TSB-67 link values.

B. The warranty shall stipulate that all products used in this installation meet the prescribed mechanical and transmission specifications for such products as described in ISO/IEC 11801, ANSI/TIA/EIA-568-A, or EN 50173. Quality and workmanship evaluation shall be solely by the Owner and designated representatives.
   1. Upon completion of the project, the Owner's technical representative will perform a final inspection of the installed cabling system with the Contractor's project foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the Drawings, and that the installation meets the aesthetic expectations of the customer.
   2. Upon receipt of the test documentation, the Owner reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Owner testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If significant discrepancies are found, the contractor will be notified for resolution.
   3. During the three-week period between final inspection and delivery of the test and as-built documentation, the customer will activate the cabling system. Owner will validate operation of the cabling system during this period.
   4. Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as-built documentation, and successful performance of the system for a two-week period will constitute acceptance of the system.

PART 2 PRODUCTS

2.01 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.

2.02 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.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.03 COLOR CODES

A. The following color code applies to products specified under this section:

	Permanent Link Cabling Jacket	Cabling Hardware	TR Patch Cords	Workstation Patch Cords
Data Outlets	Blue	Blue	Blue	Blue
Voice Outlets	Blue	White	White	White
Wireless Access Points	Yellow	Yellow	Yellow	Yellow
IP Cameras	Green	Green	Green	Green
IP Access Control	Violet	Violet	Violet	Violet
Fire Alarm	Red	Red	Red	Red

B. Note: Permanent link cabling jacket for indoor/outdoor cabling to be black. Hardware and patch cords to be color coded as noted above.

2.04 CATEGORY 6A TWISTED PAIR CABLE

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

B. Indoor Cabling Product: Subject to requirements, provide Commscope #CS44P series cabling.

C. Indoor/Outdoor Cabling Product: Subject to requirements, provide Commscope #CS44P-IO series cabling.

D. Physical Characteristics:
1. Conductor Gauge: 23 AWG
2. Nominal Outside Diameter: 0.285 in
3. Separator type: Bisector
4. Shielding/Screening: None (UTP)
5. Environmental Rating: Plenum (CMP)
6. Jacket Color: Color code by application per color code article in this section.

E. Performance Characteristics:
1. Characteristic impedance: 100-ohm.
2. Operating Frequency: 500MHz
3. Transmission Standards: ANSI/TIA-568.2-D, ISO/IEC 11801 Class E_A
4. Remote Power: IEEE 802.3bt compliant when installed according to TIA TSB-184-A

2.05 CATEGORY 6 TWISTED PAIR CABLE

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

B. Indoor Cabling Product: Subject to requirements, provide Commscope #CS37P series cabling.

C. Indoor/Outdoor Cabling Product: Subject to requirements, provide Commscope #CS34P-IO series cabling.

D. Physical Characteristics:
1. Conductor Gauge: 23 AWG
2. Nominal Outside Diameter: 0.222 in
3. Separator Type: Isolator
4. Shielding/Screening: None (UTP)
5. Environmental Rating: Plenum (CMP)
6. Jacket Color: Color code by application per color code article in this section.

E. Performance Characteristics:
1. Characteristic Impedance: 100-ohm.
2. Operating Frequency: 400MHz
3. Transmission Standards: ANSI/TIA-568.2-D, ISO/IEC 11801 Class E
4. Remote Power: IEEE 802.3bt compliant when installed according to TIA TSB-184-A

2.06 TWISTED PAIR CABLE HARDWARE

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

B. Manufacturer: Subject to compliance with requirements, provide products by the following:
   1. Commscope (Unless otherwise noted)
   2. Semtron (Faceplates)

C. General Requirements for Twisted Pair Cable Hardware:
   1. Comply with the performance requirements of Category 6A or Category 6, as applicable to the specified cabling.
   2. Comply with ANSI/TIA-568-2.D, 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 same manufacturer as twisted pair cable, from single source.

E. Patch Cables: Factory-made, four-pair cables; terminated with an 8P8C modular plug at each end.
   1. Patch cables shall have bend-relief-compliant boots and color-coded icons to ensure performance.
   2. Cable assemblies shall meet the performance requirements of ANSI/TIA-568-2.D
   3. Cable assemblies shall utilize the color scheme defined above.
   4. Provide one (1) 10-foot workstation/device patch cable and one (1) 6-foot distribution frame patch cable per installed data or telephone jack indicated on plans.
   5. For wireless access points, provide one (1) 10-foot Category 6A workstation/device patch cable and one (1) 6-foot Category 6A distribution frame patch cable per installed WAP drop indicated on plans.
   6. For IP video surveillance cameras, provide a one (1) 10-foot workstation/device patch cable and one (1) 6-foot distribution frame patch cable per installed data or telephone jack indicated on plans.

F. 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-568-2.D.
   3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:
   1. Female; eight-position; modular using connectors designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
   2. Insulation displacement connectors (IDC) shall be capable of terminating 22-24 AWG solid or 24 AWG stranded conductors. The insulation displacement contacts shall be paired with additional space between pairs to improve crosstalk performance.
   3. Designed to snap-in to a patch panel or faceplate.
   4. Standard: Comply with TIA-568-2.D requirements.
   5. Marked to indicate transmission performance.
   6. Jacks installed in faceplates shall match the color of the cable per the type of system as defined above.
   7. The number next to data symbol on Drawings indicates the quantity of data lines/jacks at that location, duplex outlets are not numbered. One jack shall be provided at the end of each cable run.

H. Faceplate: Each data or telephone jack shall be terminated and mounted in a suitable faceplate for all wall, enclosure, millwork, floor box, modular furniture, etc. locations.

1. Four-port, vertical single gang faceplates designed to mount to single gang wall boxes. Faceplate shall match manufacturer for jacks at all locations. Provide blank insert covers for unused station ports.
2. Above ceiling should have a two-port plenum surface box.
3. Faceplate:
   a. Provide stainless steel plates for use with snap-in jacks. Jacks shall be held flat to plane of faceplate.
   b. Plates shall accommodate any combination of twisted pair, optical fiber, and coaxial work area cords.
   c. Plates shall include label positions.
   d. Plates shall complying with general faceplate requirements in Division 26 Section "Wiring Devices."
   e. Product: Subject to requirements, provide Semtron #1FM-(4)0E-AMP-LAB
4. Wall Telephone Station Jack:
   a. Provide a Stainless steel wall plate for use with one (1) snap-in jack, with telephone wall set mounting studs and without label position(s).
   b. Product: Subject to requirements, provide Semtron #1FM-OE-AMP-PHONE

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

2.07 IDENTIFICATION PRODUCTS

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

B. Labeling software shall be able to produce complex unique identifiers of up to 12 independent segments. Labeling software shall be capable of inserting symbols and any standard true type font as well as capable of saving individual build information and fine-tuning print adjustments.

2.08 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.09 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-2.D.

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

E. Prepare test and inspection reports.

PART 3 EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways, cable trays, and J-hooks, except within consoles, cabinets, desks, and counters. 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 Division 26 Section "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.

3.02 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, racks, and cable trays specified in Division 27 Section "Communications Equipment Room Fittings."

B. Comply with Division 26 Section "Pathways for Communications Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.03 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-568-2.D.
   2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
   3. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
   4. Cables shall be dressed and terminated in accordance with the recommendations in ANSI/TIA-568-C standard, manufacturer’s recommendations, and/or best industry practices.
   5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels. Cable jacket shall be maintained as close as possible to the termination point.
   6. Do not untwist twisted pair cables more than 1/4 inch from the point of termination to maintain cable geometry.
   7. Cables shall be neatly bundled and dressed to their respective panels.
   8. Each panel shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack.
   9. 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.
   10. 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.
   11. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   12. 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.
   13. 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.
   14. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.

15. Service Loops:
    a. Provide 10-foot-long service loop on MDF/IDF end of all cabling.
    b. Provide 3-foot-long service loop at workstation end of all Data/Voice drops.
    c. Provide 10-foot-long service loop at all camera drops with a mod plug on the end.
    d. Provide 10-foot-long service loop at all WAP drops.
16. 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. The cable's minimum bend radius of 4 times the cable diameter and maximum pulling tension of 25 lbs shall not be exceeded.
17. Horizontal distribution cables shall be bundled in groups of not greater than 24 cables, in accordance with TSB-184-A and TIA-568.2-D standards for supporting Power Delivery over balanced twisted-pair cabling.

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. At no point shall cables rest on acoustic ceiling grids or tiles. All communications cable shall be supported from the building structure and bundled.
3. The cable support system shall provide a protective pathway to eliminate stress that could damage the cabling. The cable shall not be crushed, deformed, skinned, crimped, twisted, or formed into tight radius bends that could compromise the integrity of the cabling.
4. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
5. Cables shall not be attached to ceiling grid or lighting support wires.
6. Where light support for drop cable legs is required, install clips to support the cabling.
7. Cables shall be installed above fire sprinkler piping and shall not be attached to the system or any ancillary equipment or hardware.
8. Cabling system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

D. Cable in Conduit Installation:
1. Communications cables shall be run in conduits, where stubs are provided, from wall or floor jacks to accessible areas above finished ceilings. Conduit shall be required only within walls and concealed spaces to provide access.
2. Provide bushings to protect the cable from damage for conduit ends, box openings, and passage through metal studs.
3. All boxes installed for structured cabling shall be provided with cover plates. Where a box has been cut in but no cabling is to be installed, provide blank cover plate or at Architect's option remove box and patch substrate.

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 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.

3. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
4. Do not route any data cable within two feet of any light fixture, HVAC unit, service access area, electric panel, or any device containing a motor or transformer.
5. Cabling routed into electrical equipment enclosures (e.g. for connection of metering equipment) shall be enclosed in properly grounded conduit from where it enters the room to the entry into the panel.

3.04 INTERIOR WIRELESS ACCESS POINT JACK LOCATIONS

A. For ceiling-mounted WAP locations: provide a surface mount housing “biscuit block” for two jacks with label window, blank module, Category 6a non-keyed RF-45 data jack, and Category 6a cable to nearest MDF/IDF patch panel.

B. For wall-mounted WAP locations: provide a recessed 4" sq. box w/ 1G ring and 1" conduit stub-up to above accessible ceiling (U.O.N.) at height noted on drawings. Trim out box in accordance with WAP manufacturer's instructions.

C. Label the cable run designator(s) in a visible location on brackets/housings/enclosures and on the ceiling grid bar at jack locations that are concealed above a drop ceiling.

3.05 INTERIOR CAMERA JACK LOCATIONS

A. For ceiling-mounted camera locations: provide a surface mount housing “biscuit block” for two jacks with label window, blank module, Category 6 non-keyed RJ-45 data jack, and Category 6 cable to nearest MDF/IDF patch panel.

B. For wall-mounted camera locations: provide a recessed 4" sq. box w/ 1G ring and 1" conduit stub-up to above accessible ceiling (U.O.N.) at height noted on drawings. Trim out box in accordance with camera manufacturer's instructions.

3.06 EXTERIOR CAMERA JACK LOCATIONS

A. Provide a data jack surface mounted inside the building on the wall in a concealed and accessible location at least 12-inches above the finished ceiling. Surface mount housing shall be a “biscuit block” for two jacks with label window, blank module, Category 6 non-keyed RF-45 data jack, and Category 6 cable to nearest MDF/IDF patch panel.

B. Adjacent to jack provide a 3/4-inch rigid threaded conduit stub passing through the exterior wall with a temporary threaded pipe-cap exposed, making the stub ready to thread-in to the device weather proof backbox/enclosure.

3.07 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Firestopping."

B. Comply with requirements in Division 27 Section “Common Communications Requirements.”

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

D. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.08 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-B 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. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.09 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Each patch panel jack, wall plate jack, terminal cabinet connector, and both ends of each cable run shall be labeled with a cable scheme run designator machine printed labels.

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, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:
   1. Cables shall be identified by a self-adhesive label.
   2. 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.
   3. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties.
   4. A cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the coverplate.
   5. Cable labels shall not be obscured from view.
   6. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   7. 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.
   8. 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. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Division 27 related devices should utilize a yellow identification marker on the ceiling grid.

F. 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.
   2. Labels shall be machine printed. Type shall be 3/16 inch in height.

G. Labeling system shall designate the cable origin and destination and a unique identifier for each cable within the system. Racks and patch panels shall be labeled to identify the location within the cabling system infrastructure.

H. All labeling shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

I. All labels shall incorporate room numbers from the final Owner’s room numbering scheme. Coordinate with Owner to obtain final room numbers prior to applying labels.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

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. All UTP cabling shall be certified to meet and/or exceed the specifications as set forth for Category 6-CLASS E/D Permanent Link Testing. Testing shall meet TIA/EIA TSB-95 for Category 6.
      a. Test instruments shall meet or exceed applicable requirements in TIA-568-2.D. 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.
   4. Certifications shall include the following parameters for each pair of each cable installed:
      a. Characteristic Impedance 100 Ohm +/- 15%.
      b. Wire map (pin to pin connectivity).
      c. Permanent Link, station cable from patch panel to jack, should not exceed 295 feet (Channel length not to exceed 328 feet).
      d. Detect split pairs and number of pairs present, 4 pairs required.
      e. Attenuation <21.3 dB @ 100 MHz, < 35.9 dB @ 250 MHz.
      f. Return Loss < 26.8 dB @ 100 MHz, < 20.5 dB @ 250 MHz.
      g. NEXT > 39.9 dB @ 100 MHz, > 33.1 dB @ 250 MHz.
      h. PS NEXT > 37.1 dB @ 100 MHz, > 30.2 dB @ 250 MHz.
      i. ELFEXT > 23.3 dB @ 100 MHz, > 15.3 dB @ 250 MHz.
      j. PS ELFEXT > 20.3 dB @ 100 MHz, > 12.3 dB @ 250 MHz.
      k. ACR > 18.6 dB @ 100 MHz, > -2.8 dB @ 250 MHz.
      l. PS ACR > 15.8 dB @ 100 MHz, > -5.7 dB @ 250 MHz.

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

F. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.

G. Prepare test and inspection reports.

3.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer’s original, unopened, protective containers and packaging, with labels clearly identifying product name and manufacturer.
   1. Store materials in secure, clean, and dry area indoors in accordance with manufacturer’s instructions.

2. Protect materials and finish from damage and moisture during handling and installation.

END OF SECTION

SECTION 27 4116.00
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT - COMMON REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Refer to all of the Contract Documents, including but not limited to the E- and T- series sheets, for installation locations and quantities of devices described herein.

1.02 SUMMARY

A. Section includes:
   1. Common requirements for audio-video systems as described in the corresponding sections and on drawings, including:
      a. Conference Room AV
      b. Large Group Instruction (LGI) AV
      c. Classroom AV
      d. Sports Field AV
      e. Dance Room AV

B. Reference Project drawings for particular locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Installation shall comply with all applicable codes and standards in effect at the job site and as indicated in the Drawings and Specifications
   2. Division 26 Section "Raceways and Boxes for Electrical Systems" for boxes and raceways.
   3. Division 27 Section “Grounding and Bonding for Communications Systems” for grounding and bonding requirements at head end equipment racks, frames, and enclosures.
   4. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

1.03 DEFINITIONS

A. Acronyms and Abbreviations
   1. ALS - Assistive Listening System
   2. AWG - American Wire Gauge
   3. HDMI - High-Definition Multimedia Interface standard
   4. HDBaseT - Standard for distributing high-definition video and audio signals over standard twisted pair cabling
   5. IR - Infrared
   6. PC - Personal Computer
   7. RF - Radio frequency
   8. RS-232 - Serial data interface per TIA-232
   9. RS-422 - Serial data interface per TIA/EIA-422
   10. RS-485 - Serial data interface per TIA/EIA-485
   11. TD - Teaching Display
   12. TS - Teacher Desk Station
   13. USB - Universal Serial Bus cable and connector standard

B. Major System Components include but are not limited to the items described as such in the Part 2 article names, including:

1. Display(s),
2. Loudspeaker(s),
3. Amplifier(s),
4. Signal switching and processing equipment,
5. Signal source equipment including media player(s), microphone(s), and camera(s),
6. Powered signal extender(s),
7. RF Transmitting and Receiving equipment and Antenna(s)
8. Control system processor(s) and interface(s)

1.04 PREINSTALLATION MEETINGS

A. The successful Contractor shall attend a mandatory pre-construction meeting with individuals deemed necessary by the Owner's representative prior to the start of the work. Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section "Communications Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section "Communications Shop Drawings and Submittals".

C. Product Data as follows:
   1. Bill-of-materials with part number listing of all system components, cabling, and accessories
   2. Datasheets for each type of cabling to be provided
   3. Short-form datasheets (not full user manuals—please save those for the O&M manual!) providing part numbers and basic physical and performance specifications of each Major System Component (as defined above)
   4. Datasheets for mounting hardware including load capacities

D. Shop Drawings:
   1. Floor plans and/or reflected ceiling plans showing the physical locations of devices for each system.
   2. Diagrams for power, signal, and control wiring for each type of system
   3. Rack elevations

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer/integrator, qualified layout technician, installation supervisor, and field inspector.

1.07 CLOSEOUT SUBMITTALS

A. Hardware Operational Documentation:
   1. User manuals, preferably in electronic form, for each Major System Component (as defined in 1.5(B) above).

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On compact disk or USB flash drive, complete with data files.
   3. Device address list.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. The proposing contractor and the installing contractor must be the same company. No subcontractor to the proposing audio-video contractor will be allowed for any portion of the audio-video scope of work.
2. The projector system installer shall meet all applicable regulations of the State of Texas and Department of Labor insofar as they apply to this type of system. The bidder shall be a firm normally employed in the audio-video industry and shall provide a reference list of five (5) projects of comparable size or larger and contact names confirming successful completion.
3. The bidder shall have an authorized service center within 75 miles of the project's location for the brand of equipment that is submitted for bid. The Owner reserves the right to perform an onsite inspection.
4. The bidder must produce a letter from the manufacturer guaranteeing the delivery of all the equipment outlined in the specification herein.

B. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. NFPA 70 – National Electrical Code.
2. Local Codes and Amendments.

C. Other References:
1. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
2. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
3. TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.09 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of AV system(s) that fail in materials or workmanship within one year, or period specified in products section.

B. Special Warranty: Installer agrees to repair AV System(s) and/or replace components, cabling, etc. that fail in materials or workmanship within specified warranty period.
1. Special Warranty Period: One year from date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Incidental and Miscellaneous Appurtenances: Contractor shall include in his bid and provide all incidental and/or miscellaneous appurtenances, including but not limited to power supplies, expansion cards, brackets, etc. as required for a complete and operational system with all functionalities specified herein, whether or not such appurtenances are identified herein.

B. Materials: Materials shall be as listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the TIA/EIA specifications.

C. All products shall be new and brought to the job site in the original manufacturer's packaging.

D. Electrical components (including innerduct) shall bear NRTL and FCC listings as required by applicable law.

2.02 CONFERENCE ROOM AV

A. Refer to section 274116.23 for products and procedures specific to this scope.

2.03 LGI AV

A. Refer to section 274116.50 for products and procedures specific to this scope.

2.04 CLASSROOM AV

A. Refer to section 274116.51 for products and procedures specific to this scope.

2.05 SPORTS FIELD AV

A. Refer to section 274116.65 for products and procedures specific to this scope.

2.06 DANCE ROOM AV

A. Refer to section 274116.71 for products and procedures specific to this scope.

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 PREPARATION

A. Furnish in a timely fashion all floor boxes, back boxes, and other specialty enclosures and appurtenances which are to be installed by other trades.

3.02 GENERAL EQUIPMENT INSTALLATION

A. Comply with NECA 1.

B. Furnish cabling, plates, and labor necessary for the complete installation of the AV System architectural infrastructure, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

C. Refer to division 27 section AUDIO-VIDEO CABLING AND ACCESSORIES for detailed requirements and standards applicable to cabling.

D. Equipment shall be fixed firmly in place with proper types of mounting hardware. Equipment affixed to the building structure shall be self-supporting with a safety factor not less than three U.O.N.

3.03 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
   1. Audio DSPs, Video Switchers, and Processors (where applicable)
   2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
   3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.04 IDENTIFICATION

A. Label each cable at both ends using machine-printed adhesive or heat shrink labels.

B. Labels shall include identifying information corresponding to cabling diagram provided in shop drawing and Operator Manual submittals.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, 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.

3.06 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units. Separate training shall be provided for each type of system installed.

END OF SECTION

SECTION 27 4116.28
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR CONFERENCE ROOMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of owner-furnished flat panel displays and display mounts
   2. Provide audio-video infrastructure as described herein and on drawings, including:
      a. Cabling and plates
      b. Other infrastructure and accessories appurtenant to the AV functions of the room

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter/Receiver Pair, Wall Plate Transmitter Type: (F1)
   1. Transmitter and receiver device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Devices shall receive power via HDBaseT output.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty #DL-1H1A-WPKT-W or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

PART 3 EXECUTION

3.01 OFCI DEVICE INSTALLATION

A. Install flat panel displays and display mounts provided by owner at display location shown on plans.

END OF SECTION

SECTION 27 4116.50
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR LGI

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Ceiling-mounted projector display systems
      b. Display mounts
      c. Local sound and Voice Enhancement systems
      d. Integrated touch screen control hardware and software appurtenant to the above
      e. Cabling, plates, and other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: DISPLAYS

A. Projector, LGI: (VP-L1)
   1. Provide 7,000 Lumen Video Projector with 20000-hour maintenance free laser-phosphor light source, standard lens, and WUXGA minimum native resolution.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Epson #Powerlite L730U or comparable product by one of the following:
      a. Epson
      b. NEC
      c. Panasonic
   3. Basis-of-Design Mount: Subject to compliance with requirements, provide Chief #RPMAUW plus mounting column, structural attachment bracket(s), and ceiling escutcheon, or comparable product by one of the following:
      a. Peerless Mounts
      b. Projector Manufacturer

2.02 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. LGI Speakers: (SL).
   1. Ceiling-mounted high-output distributed loudspeaker with 6” cone LF, coaxial HF, and integral 70V transformer.
   2. Tap at 68W.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide JBL #Control 226C/T or comparable product by one of the following:
      a. Community
      b. Electro-Voice (EV)
      c. QSC
      d. Tannoy
      e. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, LGI (AMP-L1)

1. Amp shall provide two channels of amplification for 70V speaker zones, with 300W per channel
2. Amp shall include auxiliary contacts for power-down on fire alarm.
3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. Ashly
   b. Lab Gruppen
   c. QSC
   d. Yamaha

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-L)
1. DSP shall facilitate mixing and routing of audio
2. DSP shall include ethernet and RS232 control
3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.
4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
   a. Crestron
   b. Extron
   c. Kramer
   d. QSC

B. Video Presentation Switcher / Audio Demux: (VSD-L1)
1. Switcher shall accept HDBaseT and HDMI sources and provide means to scale and switch video signals from its inputs to HDBaseT and HDMI outputs.
2. Switcher shall provide de-multiplexed audio output from the presently selected video to the DSP.
3. Switcher shall accept RS-232 control
4. Basis-of-Design Product: Subject to compliance with requirements, provide Kramer #VP-440H2 or comparable product by one of the following:
   a. AMX
   b. Aten
   c. Atlona
   d. Crestron
   e. Extron
   f. Intelix
   g. Key Digital

2.05 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1)
1. Minimum Supported media sources: CD, USB, Bluetooth
2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
3. Features:
   a. Tempo control for playback.
   b. Web-browser based network control.
   c. Infrared remote.
4. Player shall be rack-mountable, 1U form factor.
5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.06 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter, Wall Plate Type: (VTX-L1)
   1. Transmitter device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Devices shall receive power via HDBaseT output.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide Kramer #WP-789T or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

2.07 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-L1, WMRX-L2, WMRX-L3)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide (2) Shure #QLXD24/SM58 (handheld kit), and (1) #QLXD14/85 (lav kit), or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

B. Wireless Microphone Antenna Distribution: (WMAD-L1)
   1. Provide 4-way antenna distribution system for distribution of antenna signal to LGI mic receivers.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #UA844+SWB or comparable product by one of the following:
      a. RFVenue
      b. Sennheiser

C. Wireless Microphone Architectural Remote Antenna
   1. Provide dual-feed Architectural diversity antenna for UHF wireless microphones.
   2. Color of antenna to be white
   3. Basis-of-Design Product: Subject to compliance with requirements, provide RFVenue #D-ARC

D. Assistive Listening: (TAS-TX)
   1. Unit shall provide compliant assistive listening service for accessibility via FM beltpack packaged with unit or via wifi transmission to mobile app
   2. Connect network to owner data network for streaming of accessible audio.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide Williams #FM 558 Pro or approved equal.

2.08 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Processor: (CP-L1)
   1. Processor shall facilitate custom, integrated control programming for control of all AV system devices, integration with lighting and shade controls, etc. in space

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    a. Crestron
    b. Extron
    c. Kramer
    d. QSC

B. 7” Touch Screen Control: (CT-L1)
1. 7” Recessed Mount Programmable Touch Screen Controller with Custom Graphical Interface
2. LGI touchscreen to mount on wall near input plate as noted.
3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    a. Crestron
    b. Extron
    c. Kramer
    d. QSC

C. AV Control Network Switch, 5-port (NSW-L1):
1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
    a. Aruba
    b. Cisco
    c. Crestron
    d. Extreme Networks
    e. Netgear

2.09 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
1. Audio DSPs, Video Switchers, and Processors (where applicable)
2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.02 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems

2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
1. Connect power as described above.
2. Complete equipment installation and startup checks according to manufacturer's written instructions.
3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
5. Verify each wired AV signal path passes signal.
6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
7. Update firmware and software on all installed equipment to latest available version
8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.03 FINAL ACCEPTANCE TESTING WITH OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for inspection by representatives of the Owner.
   a. Acceptance testing will include operation by the Owner of each major system and other components (i.e., microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.
   b. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

B. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, 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.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4116.51
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR CLASSROOMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of owner-furnished flat panel displays and display mounts.
   2. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound and Voice Enhancement systems
      b. Cabling and plates
      c. Other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: HDBASET & AV-OVER-IP SIGNAL EXTENDERS

A. HDBaseT Transmitter/Receiver Pair, Wall Plate Type Transmitter, with USB: (TS)
   1. Transmitter device shall permit HDCP-compliant transport of 4k60, 4:2:0 HDMI video from input location to destination over twisted pair cabling.
   2. Device shall be US 1-gang wall plate form factor.
   3. Transmitter shall receive power via HDBaseT output.
   4. System shall include USB extender
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Liberty #DL-1H1A1U or comparable product by one of the following:
      a. Aten
      b. Atlona
      c. Crestron
      d. Extron
      e. Kramer
      f. Liberty AV

2.02 MAJOR SYSTEM COMPONENTS: VOICE ENHANCEMENT SYSTEM COMPONENTS

A. Typical Classroom Voice Enhancement System: (TA)
   1. Description: Provide complete packaged classroom voice enhancement solution with integral loudspeaker in plenum-rated ceiling box.
   2. System amplifier and processing equipment shall be housed in ceiling plenum box
   3. Where multiple 'TA's are shown in a room, they shall be interconnected to function as a single system per manufacturer instructions.
   4. Connect teaching display analog output with 3.5mm input on 'TA's.
   5. Set up / pair microphone accessories per manufacturer instructions.
   6. Products: Subject to compliance with requirements provide the following for each classroom where one or more 'TA's is indicated:
      a. Lightspeed Topcat (#TCN) In-ceiling Classroom Audio System. For rooms with multiple 'TA' devices shown, provide the quantity indicated.
      b. Lightspeed Flexmike (#FMN) Pendant-Style RF wireless teacher microphone

c. Lightspeed Sharemike (#SMN) Handheld RF wireless studend microphone
d. Lightspeed microphone cradle charger(s) with space for all microphones provided.

2.03 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Startup Service.
1. Complete equipment installation and startup checks according to manufacturer's written instructions.
2. Set coordinated radio channels on wireless microphone systems, etc. per manufacturer's instructions.
3. Verify each wired AV signal path passes signal.

B. Prepare test and inspection reports.

3.02 OFCI DEVICE INSTALLATION

A. Install flat panel displays and display mounts provided by owner at display location shown on plans.

END OF SECTION

SECTION 27 4116.65
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR SPORTS FIELDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound systems
      b. Integrated control hardware and programming
      c. Cabling and platesother infrastructure appurtenant to the above
      d. Other infrastructure appurtenant to the above

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. Press-Box Mounted Speakers: (SP).
   1. Press-box mounted, high-output loudspeaker with 12” cone LF, coaxial HF, and integral 70V transformer.
   2. Speakers to be weather resistant, rated for installation outdoors.
   3. Provide compete with yoke and hard for mounting to press box.
   4. Connect to amp in low-impedance configuration per manufacturer instructions..
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Community R.25-94z or comparable product by one of the following:
      a. Electro-Voice (EV)
      b. JBL
      c. Others by Engineer Approval.

2.02 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, Large Zones (AMP-Px).
   1. Amp shall provide two channels of amplification, with 600W nominal per channel
   2. Basis-of-Design Product: Subject to compliance with requirements, provide Crown #DCi2|600 or comparable product by one of the following:
      a. Ashly
      b. Lab Gruppen
      c. QSC
      d. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-Px)
   1. DSP shall facilitate mixing and routing of audio
   2. DSP shall include ethernet and RS232 control
   3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.

4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
   a. Crestron
   b. Extron
   c. Kramer
   d. QSC

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1, MP-D1)
   1. Minimum Supported media sources: CD, USB, Bluetooth
   2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
   3. Features:
      a. Tempo control for playback.
      b. Web-browser based network controlnfrared remote.
      c. nfrared remote.
   4. Player shall be rack-mountable, 1U form factor.
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.05 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-Px)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #QLXD24/SM58 (handheld kit), #QLXD14/85 (lav kit), one of each type per pressbox, or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

B. Wireless Microphone Antenna Distribution: (WMAD-1)
   1. Provide RF splitter and bias tees for connection of antennas to sound system per manufacturer instructions. Mount antennas on front of rack.

2.06 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Panel: (CP-Px):
   1. Provide network-connected remote for DSP. Unit shall be PoE powered and programmed to control volume, and source selection on DSP.
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by DSP manufacturer.

B. AV Control Network Switch, 5-port (NSW-L1, NSW-D1):
   1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
   2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
   3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
      a. Aruba
      b. Cisco
      c. Crestron
      d. Extreme Networks

e. Netgear

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 EXTERIOR INSTALLATION REQUIREMENTS

A. In addition to general installation requirements, the following shall apply to sports field systems:
   1. Weather seal penetrations through building exterior walls using silicone sealant or similar.
   2. Caulk or seal around top and sides of all plates, speaker brackets, etc. installed on building exterior

B. The following modifications to the general installation requirements shall apply to sports field systems:
   1. In lieu of plenum-rated cabling, provide cabling rated for exterior damp location use. Cabling shall be UV and weather resistant.

3.02 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
   1. Audio DSPs, Video Switchers, and Processors (where applicable)
   2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
   3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.03 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
   1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems
   2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
   1. Connect power as described above.
   2. Complete equipment installation and startup checks according to manufacturer's written instructions.
   3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
   4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
   5. Verify each wired AV signal path passes signal.
   6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
   7. Update firmware and software on all installed equipment to latest available version

8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, 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.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4116.71
INTEGRATED AUDIO-VIDEO SYSTEMS AND EQUIPMENT FOR DANCE REHEARSAL ROOM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Provide complete instructional audio-video systems as described herein and on drawings, including:
      a. Local sound systems
      b. Integrated touch screen control hardware and software.
      c. Cabling and plates.
      d. Other infrastructure appurtenant to the above.

B. Reference Project drawings for locations, quantities, and coordination with other trades.

C. Related Requirements:
   1. Division 27 Section "Integrated Audio-Video Systems and Equipment - Common Requirements for common requirement applicable to all AV systems.
   2. Division 27 Section “Audio-Video Cabling and Accessories” for system cabling and accessories and related procedures and standards.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS: LOUDSPEAKERS

A. Dance Gym Speakers: (SG).
   1. Ceiling-mounted high-output distributed loudspeaker with 12” cone LF, coaxial HF, and integral 70V transformer.
   2. Provide compete with back can and clamps for mounting to exposed structure.
   3. Connect speakers to amp in low impedance configuration, two speakers per channel.
   4. Basis-of-Design Product: Subject to compliance with requirements, provide JBL #Control 322C or comparable product by one of the following:
      a. Community
      b. Electro-Voice (EV)
      c. Tannoy

2.02 MAJOR SYSTEM COMPONENTS: AMPLIFIERS

A. Audio Power Amp, Large Zones (AMP-D1).
   1. Amp shall provide four channels of amplification, with 600W per channel
   2. Amp shall include auxiliary contacts for power-down on fire alarm.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide Crown #DCi4|600 or comparable product by one of the following:
      a. Ashly
      b. Lab Gruppen
      c. QSC
      d. Yamaha

2.03 MAJOR SYSTEM COMPONENTS: SIGNAL SWITCHING AND PROCESSING

A. Audio DSP: (DSP-D)
   1. DSP shall facilitate mixing and routing of audio
   2. DSP shall include ethernet and RS232 control
   3. Provide extra I/O break-in/breakouts to facilitate input/output configuration indicated on one-line diagram.

4. Basis-of-Design Product: Subject to compliance with requirements, provide BSS #BLU-100 or comparable product by one of the following:
   a. Crestron
   b. Extron
   c. Kramer
   d. QSC

2.04 MAJOR SYSTEM COMPONENTS: SIGNAL SOURCES

A. Network Media/CD/Bluetooth Audio Player (MP-L1, MP-D1)
   1. Minimum Supported media sources: CD, USB, Bluetooth
   2. Minimum Supported Bluetooth profiles: A2DP and/or AVRCP.
   3. Features:
      a. Tempo control for playback.
      b. Web-browser based network controlnfrared remote.
      c. nfrared remote.
   4. Player shall be rack-mountable, 1U form factor.
   5. Basis-of-Design Product: Subject to compliance with requirements, provide Denon DN-700CB or comparable product.

2.05 MAJOR SYSTEM COMPONENTS: RF TRANSMITTERS, RECEIVERS, AND ANTENNAS

A. Wireless Microphone Systems: (WMRX-D1)
   1. Provide UHF wireless microphone transmitter/receiver pair
   2. Provide rechargeable battery for each transmitter.
   3. Provide 2-space charging dock for each room.
   4. LGI shall have two beltpack transmitters with lavalier and one handheld transmitter.
   5. Dance shall have one beltpack transmitter with headset.
   6. Basis-of-Design Product: Subject to compliance with requirements, provide Shure #QLXD24/SM58 (handheld kit), #QLXD14/85 (lav kit), and #QLXD14/SM35 (headset kit), or comparable product by one of the following:
      a. Audio Technica 3000 Series
      b. Sennheiser EW-D Series

2.06 MAJOR SYSTEM COMPONENTS: CONTROL SYSTEM PROCESSOR & INTERFACES

A. Control Processor: (CP-2)
   1. Processor shall facilitate custom, integrated control programming for control of all AV system devices, integration with lighting and shade controls, etc. in space
   2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron
      c. Kramer
      d. QSC

B. 7” Touch Screen Control: (CT-D1)
   1. 7” Recessed Mount Programmable Touch Screen Controller with Custom Graphical Interface
   2. LGI touchscreen to mount on wall near input plate as noted.
   3. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Crestron
      b. Extron

c. Kramer
d. QSC

C. AV Control Network Switch, 5-port (NSW-D1):
1. Provide 5-port, Unmanaged Gigabit network switch for AV Control Network
2. Switch to be PoE+ (802.3at) enabled, 83W total power budget.
3. Subject to requirements, provide product indicated on drawings or comparable product manufactured by one of the following:
a. Aruba
b. Cisco
c. Crestron
d. Extreme Networks
e. Netgear

2.07 ACCESSORIES

A. I/O Plates: Provide Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide plates by Penn Elcom, RDL, Whirlwind, or approved equals.

B. Connectors: Provide connectors at Input/Output Plates per the basis of design indicated on drawings. Subject to requirements, provide connectors by Leviton, Neutrik, or approved equals.

PART 3 EXECUTION

3.01 SEQUENCED RACK POWER CONNECTIONS

A. Connect the following equipment to constant (non-sequenced) power: Network Switches, Rack Lighting, Control System Processors & Interfaces

B. Connect equipment to power sequencer steps as follows:
1. Audio DSPs, Video Switchers, and Processors (where applicable)
2. Powered extenders, Wireless Microphones, Media Players, Assistive Listening
3. Power Amplifiers, Powered Loudspeakers

C. Exact sequence may vary according to equipment requirements, but in general, amplifiers should turn on last and turn off first to avoid speaker damage from switching transients

3.02 FIELD QUALITY CONTROL & SYSTEM STARTUP

A. Initial Testing and Pre-Startup Testing:
1. Perform field-survey of site RF conditions for use in startup of wireless microphones and other RF systems
2. Test speaker zone wiring with an Audio Impedance Tester after speaker installation and prior to connecting and powering on amplifiers to check for shorts, opens, and overload conditions.

B. Startup Service.
1. Connect power as described above.
2. Complete equipment installation and startup checks according to manufacturer's written instructions.
3. Set up peak limiters on each DSP output to amplifiers for loudspeaker protection.
4. Set coordinated radio channels on wireless microphone systems, assistive listening systems, etc. using RF survey data collected in pre-startup and mic manufacturer’s frequency coordination software.
5. Verify each wired AV signal path passes signal.
6. Set equalization curves and delays on loudspeakers as needed to deliver clear intelligible audio to occupants.
7. Update firmware and software on all installed equipment to latest available version

8. Load control system program into control processors and verify all control functions operate correctly. Set limits (or coordinate with system supplier to set limits) on projection screens, shade controls, etc.

C. Prepare test and inspection reports.

3.03 FINAL ACCEPTANCE TESTING WITH OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for inspection by representatives of the Owner.
   a. Acceptance testing will include operation by the Owner of each major system and other components (i.e., microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.
   b. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

B. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner’s Representative establishing the “In Warranty” date. The warranty period will not commence until the Final Acceptance Test is completed.

C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, 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.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for not less than two years.

3.06 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 27 4123
AUDIO-VIDEO CABLING AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for cabling and accessories for audio-video systems.

B. Related Requirements:
   1. Installation shall comply with all applicable codes and standards in effect at the job site and as indicated in the Drawings and Specifications
   2. Division 27 Section “Pathways for Communication Systems” for pathways and support for system cabling.

1.02 DEFINITIONS

A. Acronyms and Abbreviations
   1. ALS - Assistive Listening System
   2. AWG - American Wire Gauge
   3. Cat6 - Category 6 cable as defined in ANSI/TIA 568
   4. Cat6A - Category 6A cable as defined in ANSI/TIA 568
   5. F/UTP - Twisted-pair cabling with overall foil shield, without shielding of individual pairs within the cable.
   6. HDMI - High-Definition Multimedia Interface standard
   7. HDBaseT - Standard for distributing high-definition video and audio signals over standard twisted pair cabling
   8. RF - Radio frequency
   9. USB - Universal Serial Bus cable and connector standard
   10. UTP - Twisted-pair cabling without overall shield

1.03 ACTION SUBMITTALS

A. Product Data:
   1. Cabling product data shall be included in product data submittals for systems referencing this section.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: All cabling for a given AV system (except data network drops provided by the structured cabling contractor) shall be provided by the same company providing the equipment for that AV system.

B. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
   1. NFPA 70 – National Electrical Code.
   2. Local Codes and Amendments.
   3. TIA/EIA-568-A Commercial Building Telecommunications Wiring Standard.
   4. EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces.
   5. TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
   6. TIA/EIA TSB 67 Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems.
   7. ISO/IEC 1180 Generic Cabling Standard.
   8. EN 50173 Generic Cabling Standards for Customer Premises.

PART 2 PRODUCTS

2.01 GENERAL

A. Installation: The cabling shall be installed per requirements of the manufacturer and the Project Documents utilizing materials meeting all applicable TIA/EIA standards. The Contractor is responsible for providing all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Ratings: All products shall be new and brought to the job site in the original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows unless noted otherwise:
   1. Indoor Cable: CL2P, CL3P, or CMP Plenum Rated Communications Cable
   2. Outdoor Cable: CL2, CL3, CM UV & Water Resistant, and/or Indoor/Outdoor Plenum OSP Communications Cable

C. Fire Wall Sealant: Any penetration through firewalls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved assembly.

2.02 WIRE AND CABLE

A. Constant Voltage (70.7V) Loudspeaker Cable for Distributed Loudspeaker Systems: 2-Conductor Unshielded, 14 AWG minimum, bare conductors, rated CMP (plenum). Belden 6100UE or equal.

B. Mic/Line Level Analog Audio Cable: Individually shielded & twisted pairs (count as required for application), 22AWG tinned stranded conductors, rated CMP (plenum). Belden 9451 Series or equal.

C. HDBaseT and/or Video-Over-IP Cabling: Cat 6 UTP (unless otherwise noted), rated CMP (plenum). Refer to Section 27 06 10 Voice Data System. Provide typical Category 6 RJ-45 plug termination on both ends of cable in lieu of keystone jack terminations.

D. Point-to-point HDMI Cabling, non-plenum, 25 ft (7.6 m) or less: Provide high quality cable rated for in-wall installation and HDMI 2.0 minimum. C2G #2968x or equal.

E. Point-to-point HDMI Cabling, plenum, 25 ft (7.6 m) or less: Provide high quality cable rated for plenum installation and HDMI 2.0 minimum. C2G #4252x or equal.

F. Point-to-point HDMI Cabling, plenum, greater than 25 ft (7.6 m): Provide high quality active HDMI cable rated for plenum installation and 4k60Hz minimum: C2G #4145x or equal.

G. Wireless Microphone Antenna Cabling: Provide low-loss, plenum rated 50-ohm RG8 Coaxial Cable with 10AWG solid bare copper conductor. Belden 89913 or equal with Amphenol Connex 112563 or equal connector.

H. Assistive Listening System Antenna Cabling: Provide 75-ohm coaxial cable with 20AWG solid bare copper conductor. Belden 1370P or equal, with connectors as specified by manufacturer.

I. Other equipment control cables shall be stranded wire, appropriately shielded, of gauge and number of conductors required by the manufacturer for proper operation of the system or equipment item furnished.

J. Capacities and Characteristics:
   1. All wire and cables shall be new and unused.
   2. Indoor Wire which is not portable and is not installed within equipment racks or conduit shall be plenum-rated and meet all applicable codes

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for A/V system(s) to verify pathways and/or conduits are prepared and free of sharp edges and other conditions that may damage cable prior to cabling installation.

B. Inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of the proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would indicate potential problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL CABLING INSTALLATION

A. Comply with NECA 1.

B. Furnish cabling, plates, and labor necessary for the complete installation of the AV System(s) infrastructure, in full accordance with the recommendations of the equipment manufacturers and the requirements of the drawings and specifications.

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 cable trays specified in Section 26 05 36 "Cable Trays for Electrical Systems."
   3. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

D. Install cables parallel and perpendicular to building lines where possible.

E. Support cables in accordance with Division 27 Specification Section “Pathways for Communication systems”. Cables shall not be supported by ceilings, ductwork, piping, etc.

F. Cables shall be installed and routed in such a manner that they do not interfere with the operation of equipment or removal of ceiling tiles.

G. 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.

H. Testing: Contractor shall test all installed cabling shall be tested after installation and prior to owner acceptance to confirm cabling and terminations are good and passing signals as intended. Re-terminate or replace cabling which does not pass testing.

3.03 CABLE PULLING

A. Follow manufacturers’ recommendations for regulating temperature conditions of conductors prior to installation.

B. Exercise care in handling and installing cables to avoid damage. Carefully form cables in pull boxes, enclosures, etc. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

C. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors.

D. The pulling of all wires and cable on this project shall be performed in strict compliance with applicable sections of the National Electrical Code. No conductor entering or leaving a cabinet or box shall be deflected in such a manner as to cause excess pressure on the conductor insulation. Conductors shall only be installed after insulating bushings are in place.

E. Maximum permissible pulling tensions, as recommended by the manufacturer for any given type of cable or wire installed shall not be exceeded. Utilize special remote readout equipment to ensure compliance.

F. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit.

G. Use manufacturer-approved pulling compound or lubricant where necessary, of non-conducting type. Compounds used must not deteriorate the conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

3.04 IDENTIFICATION AND LABELING

A. Color-code cables according to Division 27 Section "Common Communications Requirements."

B. Provide self-adhesive vinyl or vinyl-cloth wraparound tape machine printed marker labels, at both ends of each cable. Utilize systematic alphanumeric designations to identify cables for easy troubleshooting. Document cable labeling in O&M manual.

END OF SECTION

SECTION 27 5123
INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install a complete new intercommunication and program system for the facility as necessary. Furnish and install all equipment, accessories, and materials in accordance with the specifications and drawings to provide a complete communication system including public address paging and intercommunication functions as outlined below.
   1. A complete system includes items such as wiring, control consoles, and main distribution equipment as necessary.
   2. Integrate all components to provide a complete and functioning system.

B. Integrate the intercommunication and program system with the following systems:
   1. Owner’s Phone System.
   2. Access Control System Lockdown Sequence.
   3. Fire Alarm System

C. Intercom Features / Public Address Features: Provide system with the following minimum characteristics and features:
   1. System topology
      a. One-Way paging functionality.
      b. Individual intercom circuit for every classroom.
      c. Paging circuits to operate at 25 Volts.
      d. Connections to Owner's internal phone exchange and the public telephone system via SIP trunk.
   2. Differentiated Paging Function Types:
      a. All-call announcements and scheduled messages.
      b. Zone-specific announcements and scheduled messages.
      c. Emergency announcements with distinctive tones and/or pre-recorded messages.
   3. Time Control and Event Scheduler: Provide system with the following functions:
      a. Built-in Master Clock with unlimited events.
      b. 64 schedules.
      c. Weekly system event scheduler.
   4. Miscellaneous Features
      a. Ethernet LAN/WAN interface for district-wide all-calls and remote management.
      b. MapAssist Administrative Console with facility plan view.

D. Related Requirements:
   1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.
   2. Division 28 Section “Access Control Software and Database Management” for interface with emergency lockdown sequences.
   3. Division 28 Section "Digital Addressable Voice Evacuation Fire Alarm System" for interface with fire alarm system.

1.02 DEFINITIONS

A. FXO: Foreign eXchange Office.

B. Paging: Communication via audio messages relayed by a distributed speaker system.
   1. "One-Way", "Broadcast", or "Public Address" Paging: Audio message playback to one or more distributed locations or zones, without a means for the message source to hear return communication from the zones addressed.

C. SIP: Session Initiation Protocol, a standard protocol used in voice-over-IP telephone systems.

1.03 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 27 Section “Communications Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 27 Section “Communications Shop Drawings and Submittals”.

C. Product Data:
   1. Complete system bill of materials.
   2. Brief specification documents ("cut sheets") for each type of product.

D. Shop Drawings: The installing contractor and/or equipment supplier shall provide complete and detailed shop drawings and include:
   1. Complete floor plan drawings locating all system devices.
   2. Overall system one-line diagram.
   3. Wiring and interconnection schematics.
   4. Detailed system operational description

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data for Installer. Refer to "Quality Assurance" article for qualification requirements.

1.05 CLOSEOUT SUBMITTALS

A. Start-up Testing Documentation: When requesting Owner Acceptance Testing, submit the following documentation from the Start-up Testing procedure:
   1. A record of speaker line testing indicating DC ground resistance and line-line impedance measurement for each speaker line.

B. Operation and Maintenance Manual: For intercommunications and program systems. Collect the information in an organized format including tabs and/or PDF bookmarks delineating each of the required sections below. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Record drawings including:
      a. Plans showing location of intercom system components including head-end equipment, speakers, and user interface devices.
      b. Record of speaker tap settings.
      c. Device address list.
   2. Operation and Maintenance Documentation including:
      a. Hardware and Software operating manuals.
      b. Maintenance Parts List & supplier contact information.
   3. System Maintenance and Warranty Documentation including:
      a. A copy of the manufacturer’s standard statement of warranty on system components.
      b. Installing contractor's statement of warranty on overall system and workmanship.
      c. Warranty contact information.

C. Program Software Backup: On USB media or compact disk, complete with data files.

1.06 QUALITY ASSURANCE

A. Installing Contractor Qualifications:
   1. Contractor shall be an established electronic communication systems installer with not less than 5 years history of designing and installing similar systems. Provide, upon request by Owner or Architect/Engineer, names and addresses of similar installations.
   2. Contractor shall be an authorized distributor in good standing for the equipment supplied, with full manufacturer's warranty privileges.

B. Installing Personnel Qualifications:
   1. Technicians performing work shall be trained in the basic principles and practices of low voltage systems installation and integration.
   2. Work shall be supervised by a technician trained and certified by the manufacturer to install the equipment supplied.

1.07 COORDINATION

A. It shall be the responsibility of the installing contractor to coordinate all requirements surrounding installation of the communication system with all other trades.

B. Pre-installation Meeting: Schedule a pre-installation meeting specifically for the Intercommunications and Program System with Owner and Architect.

1.08 WARRANTY

A. Manufacturer shall warranty components of the installed system against defects in material and workmanship for a period of not less than five (5) years from the date of installation.

B. Installing contractor shall warranty workmanship and system integration for a period of not less than one (1) year after final acceptance of the Work by the Owner.

C. Defects occurring in labor or materials within the one-year warranty are to be rectified by replacement or repair. Correct detects in material or workmanship with a minimum loss of operating time at no cost to Owner.

D. Onsite Service: This Contractor, within the warranty period, is required to answer all service calls and requests for information within a 24-hour period and repair or replace any faulty item within a 24-hour period, without charge, including parts and labor.

PART 2 PRODUCTS

2.01 PRODUCTS

A. Products: Subject to compliance with requirements, provide CareHawk #CH1000. Substitutions by written Owner approval only.

2.02 GENERAL SYSTEM REQUIREMENTS

A. The intercom system shall consist of one or more central equipment cabinet(s) with modular components as needed to implement the features described herein, administrative control stations (ACSs), and station equipment including loudspeaker assemblies.

B. Provide all associated material hardware, wiring, and options as described herein to provide a complete working system, which shall meet the specified requirements.

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

D. Weather-Resistant Equipment: Listed and labeled by an NRTL for duty outdoors or in damp locations.

2.03 CENTRAL CONTROL EQUIPMENT

A. The central control equipment shall be mounted in a wall-mounted equipment cabinet. See part number schedule for listing of components.

B. The central equipment shall consist of but not be limited to the following:
   1. Provide power supplies to deliver operating DC power for the circuitry contained within the central equipment housing and all administrative control stations (ACSs).
   2. Provide a central microprocessor unit containing system memory, components, and programming necessary to implement the features specified herein.
   3. Provide zone circuit boards and amplifier modules as required to meet the system requirements for intercom zones/paths.
   4. Provide a means to automatically activate a program source between class changes.

5. Provide network IP communications modules as needed to receive district wide mass notifications and permit remote management.
6. Provide enclosure for mounting equipment. Size enclosure(s) or rack(s) to accommodate all components, plus 20 percent spare expansion room for future additions.

C. Telephone Integrations
1. The system shall integrate to the facility phone system to allow any authorized telephone system extension to:
   a. Make paging announcements to any of the zones.
   b. Initiate system tones to any area of the facility.
   c. Distribute programs to any zones and zone monitor any area of the building.
2. Integration to the Owner's VoIP phone system will utilize SIP trunking .

2.04 ADMINISTRATIVE CONTROL STATION

A. Central office communications and control are achieved via the administrative control station or "admin phone". See part number schedule below.

B. 12-Digit Keypad Selector: Initiates commands for programming and operation.

C. Volume Control: Regulates incoming-call volume.

D. LED Annunciation: Identifies stations in use. LED remains on until call is answered.

E. Speaker Microphone: Transmits intercom voice signals when used via a voice-operated switch.

F. Hard Buttons: To transfer and place calls on hold.

G. Reset Control: Cancels call and resets system for next call.

H. LCD Graphical display.

2.05 MASTER CLOCK SYSTEM

A. The system shall contain an integral Master Clock and Programmer that shall be capable of performing the scheduled functions, bells, etc. See part number schedule below.

B. The system shall provide for automatic (without user input) clock correction for Daylight Savings Time, spring ahead/fall back.

C. The system shall provide for an editing and review routine to permit the user to change and edit time events, zones, and schedules.

2.06 AMPLIFIERS

A. Amplifiers and speaker lines provided shall operate on the constant voltage principle at 25 V.

B. System amplifier sizes and quantities shall be selected according to the initial tap settings specified in Part 3. The total amplifier load in each zone or enclosure shall not exceed 80-percent of capacity provided. See part number schedule below.

C. The amplifiers shall be capable of producing their rated power output at less than 1 percent THD.

D. The amplifiers shall be designed to operate on an AC line voltage of 115 VAC.

2.07 SPEAKERS

A. Lay-in Tile Ceiling-Recessed Speakers:
1. Provide 1'x2' nominal lay-in tile replacement recessed loudspeaker assemblies.
2. All speakers shall include 4 W integral transformer and rotary tap selector.
3. Provide front-mounted volume control in Classrooms, Offices, Conference Rooms, Teacher's Lounges, and Workrooms.
4. Contractor may utilize RJ45 or 8P8C connectors and Category 5e or Category 6 cabling.
5. Finish color to be White unless noted otherwise.

6. Basis-of-design product: Subject to requirements, provide Quam #System 5 series or comparable product by manufacturers listed below.

B. Interior Ceiling-Recessed Speakers, other than lay-in tile:
   1. Provide round, 12" diameter baffle recessed loudspeaker assemblies.
   2. All speakers shall include 5W integral transformer and back can.
   3. Provide speakers with appropriate mounting supports for application.
   4. Finish color to be White unless noted otherwise.
   5. Basis of design product: Subject to requirements, provide Quam #System 21 or #Solution 3, or comparable product by manufacturers listed below.

C. Interior Structure-Mount Speakers for areas with exposed structure:
   1. Provide round, 12" diameter baffle recessed loudspeaker assemblies.
   2. All speakers shall include 5 W integral transformer and back can.
   3. Provide speakers with appropriate mounting supports for application.
   4. Finish color to be White unless noted otherwise.
   5. Basis-of-design product: Subject to requirements, provide Quam #BB2, or comparable product by manufacturers listed below.

D. Interior Wall-Recessed Speakers:
   1. Provide square recessed backbox, with acoustic foam lining and conduit stub-up to nearby cabling pathway above accessible ceiling or bottom of structure. Coordinate backbox depths with other trades.
   2. Provide 8" diameter speaker with 5 W integral transformer.
   3. Provide 12" square baffle. Finish color to be White unless noted otherwise.
   4. Basis-of-design product: Subject to requirements, provide Quam #8C10PAX/TBLU + #BS8W + #ES-8(-6), or comparable products by manufacturers listed below.

E. Interior/Exterior Wall-Recessed Vandal-Resistant Paging Horn:
   1. Provide square recessed backbox, with acoustic foam lining and conduit stub-up to nearby cabling pathway above accessible ceiling or bottom of structure. Coordinate backbox depths with other trades.
   2. Provide 16 W compression-type re-entrant horn loudspeaker with vandal-resistant square stainless steel baffle and integral transformer. Baffle finish to be White unless noted otherwise.
   3. Basis-of-design product: Subject to requirements, provide Quam #H16/SVPS + #ES-8S, or comparable products by manufacturers listed below.

F. Exterior (Damp-location) Canopy Surface Mounted Vandal-Resistand Speaker:
   1. Provide square surface-mount backbox with conduit connections and matching square vandal-resistant baffle with security torx fasteners. Finish color to be White unless noted otherwise.
   2. Provide 8" diameter moisture-resistant loudspeaker with 5W integral transformer.
   3. Basis-of-design product: Subject to requirements, provide Quam #System 1VP or comparable products by manufacturers listed below.

G. Manufacturers: Subject to requirements, comparable products by the following manufacturers are acceptable in lieu of the bases of design specified above:
   1. AtlasIED
   2. Lowell
   3. Others by prior Engineer approval.

2.08 REMOTE VOLUME CONTROL DEVICES

A. Wall-Mounted Volume Control: 10-watt, stepped, recessed autotransformer volume control in US 1-gang form factor. Volume control shall have relay coil for public address (PA) emergency override of volume control. Provide Atlas Sound #AT-10PA or Quam #QC-10P. Equivalents from all acceptable manufacturers to be accepted.

B. Remote Source Output Volume Control: Rack-mounted in remote source rack. Provide line level volume control.

2.09 REMOTE MANAGEMENT

A. Remote Scheduling: Provide all necessary components to allow for remote scheduling of intercommunications and program system.

B. Troubleshooting: Provide all necessary components to allow for remote management of system settings and issue logs.

2.10 UPS BATTERY BACK-UP

A. Acceptable Manufacturers: Liebert, Best Power, APC, TrippLite.

B. Provide UPS battery back-up for the communications system to operate a minimum of 24 hours standby then 20 minutes of operation upon loss of power.

2.11 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multi-pair, un-tinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG. Increase wire sizes as needed to account for voltage drop in long cabling runs.

B. Insulation: Thermoplastic, not less than 1/32 inch thick.

C. Plenum Cable: Listed and labeled for plenum installation.

2.12 RACEWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Division 26 Section "Pathways for Communications Systems."

B. Flexible metal conduit is prohibited.

2.13 EQUIPMENT PART NUMBER SCHEDULES: CAREHAWK CH1000

A. Central Control Equipment and Add-Ons

Equip. Name	Component Part Number	Description
CH1000 Central Cabinet (Wall Mount)	CC301	Central Controller Card
	MI100	Main Interface Card
	TC2	Telephone Interface Card
	AC1	Admin Interface Card (One per Admin Phone served)
	RAC2	Remote Audio Card
	DAF250D	300 Watt Class D Amplifier(s)
	IA5	Intercom Amplifier Card(s) (One per intercom path)
		5 volt / 12 Volt Power Supply
CH1000C Client Cabinet (Wall Mount)	CC301	Central Controller Card
	MI100C	Client Cabinet Main Interface Card
	RAC2	Remote Audio Card
	DAF250D	300 Watt Class D Amplifier(s)
	IA5	Intercom Amplifier Card(s) (One per intercom path)

Equip. Name	Component Part Number	Description
		5 Volt / 12 Volt Power Supply
Control Accessories	DAF250D	300 Watt Class D Amplifier(s) (Provide additional amps as needed to serve large speaker zones)
	SS16/SS32	16- and 32-port remote switching cards
	ACA16	Audible Call Assurance Card
	OC16	Output Contact Card
	AP1-B	Administrative Display Console (Admin Phone)
	AD2W16	16-Port Two-Wire Adapter
Telephone Accessories	VTM	VoIP Telephone Expansion Module
	VG4-G	4-port FXO Telephone Gateway
	VFS16-G/32-G	16- or 32-prt FXS Telephone Gateway
	DMS	District-wide Server
	DTM	District-wide Telephone Module
Other Optional Equipment	MPD100	Media Player (Digital Music Source)
	RK100	Rack Mount Kit
PC-Based Add-Ons	Assistant PC-Based Visual Console	
	VCCall PC-Based Call Switch	
	Tone Alerts PC-Based Tone Control	
	MapAssist Map-Based Administrative Phone & Calendar	

B. Port Equipment

Component Part Number	Description
STELVP-1	VoIP Classroom Telephone
STEL	Analog Classroom Telephone
CS100/CS35	Silicon Call-in Switch
CS45	Rocker-Style Call Switch with Privacy
CS25	Rocker-style Call Switch
CS20	Call Switch for 2-Wire Installations
CS-DCCK	2-Button (Safety Acknowledgment Blue Button)

PART 3 EXECUTION

3.01 WIRING METHODS

A. Wiring Method: Install cables in raceways and j-hooks 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 Division 27 Section "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.02 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Pathways for Communications Systems" for installation of conduits and wireways.

3.03 EQUIPMENT INSTALLATION

A. Locate equipment to accommodate millwork, fixtures, marker boards and other room equipment at no additional cost to the Owner.

B. Provide and install a PTT microphone in the front office. Coordinate location with architect.

C. Provide and install an Administrative Control Station at the following locations:
   1. Reception Desk
   2. Principal's Office.

D. General: Install new communication system components in accordance with the manufacturer's instructions.
   1. Terminate field wiring on wall-mounted cross connect blocks per manufacturer recommendations..
   2. Label cables and wiring logically, legibly, and permanently for ease of identification, using adhesive strip type labels.
   3. Provide integration of telephone system.
   4. Provide integration of EVACS fire alarm system override
   5. Provide integration of remote emergency pushbuttons.
   6. Furnish and install quantity of amps necessary to power all speakers as shown on the Drawings.

3.04 SPEAKER INSTALLATION:

A. Install new speaker types as indicated on the Drawings.

B. All speakers shall be supported from building structure at at least two points. Supports shall be independent of the work of other trades.

C. Speaker wattages shall be initially set based on the speaker type, mounting height, and area served. In general:
   1. Lay-in Speakers:
      a. Classrooms: 0.5 Watt.
      b. Typical corridors and other low-volume spaces: 1 Watt.
      c. High-volume (Ceiling > 12' AFF, < 20' AFF) spaces: 2 Watts
      d. Extra-high-volume (Ceiling > 20' AFF): 4 Watts
   2. Hard Deck Speakers:
      a. Bathrooms, locker rooms, & other low-volume spaces: 1.25 Watt.
      b. High volume (Ceiling > 12' AFF) spaces: 2.5 Watt.
   3. Exposed Structure Area Speakers: 2.5 Watt (U.O.N.)
   4. Interior Wall Recessed Speakers: 1.25 Watt (U.O.N.)
   5. Exterior Wall Recessed Speakers:
      a. Mounting Height ≥ 11' AFF: 4 Watt
      b. Other locations: 2 Watt
   6. Exterior Canopy Mounted Speakers:
      a. Mounting Height ≥ 11' AFF: 2.5 Watt
      b. Other locations: 1.25 Watt

D. Provide silicone sealant at all canopy penetrations at exterior canopies. At single-layer pre-fabricated metal canopy ("Avadeck" or similar), penetrate canopy only at upper flute.

E. Provide silicone sealant at top and sides of baffle at all exterior back box locations.

3.05 CABLING INSTALLATION:

A. Comply with NECA 1.

B. Return air plenum cable shall be used. Wherever cabling is run exposed, conduit shall be used to cover and protect wiring.

C. General 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. Do not splice cable between termination, tap, or junction points.
   3. Secure and support cables at intervals not exceeding 60 inches and not more than 12 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. Remove and discard cable if damaged during installation and replace it with new cable.
   6. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used.

D. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
   2. Suspend 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.

E. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways 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 intercommunication equipment conductors as recommended by equipment manufacturer.

F. Cabling Topology: wire system to physical zones / audio points as indicated on the Drawings and as described below:
   1. Administration and office pods.
   2. Corridors of each floor of each classroom wing or other building unit (gym, CTE, fine arts, etc.) shall be wired as separate zones.
   3. Restrooms and locker rooms shall be zoned with the nearest corridor zone.
   4. Each individual room such as and not limited to classrooms, science labs, fine arts rooms, etc. shall be wired as individual zones.
   5. Dining
   6. Library
   7. Gyms
   8. Exterior paging speakers serving different exposures and functional areas (outside fine arts, outside CTE, exterior E side, etc.) shall be wired as separate zones.

G. Tag each circuit at each end and at each terminal with a separate tag indicating the area served.

3.06 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.

3.07 SYSTEM START-UP AND INITIAL TESTING

A. Assemble and mount head end equipment per manufacturer instructions

B. Using an audio impedance tester, measure impedance of each speaker zone to verify correct tap settings and detect wiring faults. Report test signal frequency and measured zone impedance / power draw on testing report.

C. Connect speaker zones to amplifier(s) per manufacturer's instructions.

D. Program system telephone card to function with Owner's telephone system per owner preferences and manufacturer instructions.

E. Initial Testing and Adjustment: After connection to Owner's program source and telephone systems, test individual zone and all-call pages from each source. Adjust speaker volume controls, speaker tap settings, and gain staging to meet the following criteria
   1. Volume levels of program source, microphone(s), and paging from phones are balanced appropriately (e.g.: volume of bell tones should not be much louder or quieter than spoken paging messages).
   2. Sound produced by system is free from noise and distortion.
   3. Overall volume levels in spaces are sufficiently loud to ensure paging message intelligibility, and not so loud as to cause occupant discomfort.

F. 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 and independent room speaker-line matching transformers.

G. Prepare test and inspection reports.

3.08 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.
   1. Interface with access control lockdown sequence to provide emergency message and/or tone throughout the entire building during a lockdown event. Refer to access conrol system specification for lockdown sequence.
   2. Install floor plan drawings and configure building maps for user interface.
   3. Assign audio points to logical zones per Owner's preferences.

3.09 ACCEPTANCE BY OWNER

A. Upon completion of initial tests and delivery of all documents, diagrams, and project record drawings, notify the Architect in writing that the installation has been completed in accordance with the requirements of the specification and is ready for equalization and inspection by representatives of the Owner.

B. Acceptance testing will include operation by the Owner of each major system and other components (i.e. microphones, consoles, racks, loudspeakers, etc.) deemed necessary. Contractor will assist as necessary in this testing.

C. In the event the need for further adjustments or work becomes evident during acceptance testing, the Contractor will continue his work until system is acceptable at no additional cost to the Owner.

D. Contractor shall provide a Final Acceptance Test record document signed by both the Contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

E. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.

3.10 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain the intercommunications and program systems.
   1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.
   2. Provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
   3. Provide 8 hours, 4 hours on each of two days, of instruction to the Owner designated user and maintenance personnel on the use and operation of the system. Instructing personnel shall be a competent engineer or technician familiar with the installed system. Instruction times shall be arranged by the Owner.

B. All staff development training is to be coordinated through the owner’s designated representative. As training sessions are completed, the trainer will provide the school’s administrative staff and school district’s staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

3.11 POST-OCCUPANCY ADJUSTMENT

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 12 months from date of Substantial Completion, 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.

END OF SECTION

SECTION 28 0000
COMMON ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements contained in this Section apply to all Sections of this Division.

1.02 SUMMARY

A. This section includes general design requirements, administration topics, and installation for communications systems.

B. Section Includes:
   1. Common terminology and requirements used throughout this Division.
   2. Identification and labeling.
   3. Firestop systems.
   4. Sleeves for raceways and cables.
   5. Grout.

1.03 SYSTEM DESCRIPTION

A. The objective of this project is to provide complete communications systems installation including, but not limited to:
   1. Emergency Responder Radio Antenna System
   2. Access Control System.
   3. Intrusion Detection System.
   4. Video Surveillance System
   5. Digital Addressable Voice Evacuation Fire Alarm System.

1.04 STRUCTURED CABLING SYSTEM SCOPE OF WORK

A. Refer to Division 27 Sections for more information on the low-voltage structured cabling system infrastructure required for this project.

1.05 GENERAL

A. The Instructions to Bidders, General and Special Conditions, and all other contract documents shall apply to the Contractor's work as well as to each of his Sub-Contractor's work. Each Contractor is directed to familiarize himself in detail with all documents pertinent to this Contract. In case of conflict between these General Provisions and the General and/or Special Conditions, the affected Contractor shall contact the Engineer for clarification and final determination.

B. Each Contractor shall be governed by any alternates, unit prices and addenda or other contract documents insofar as may affect the work or services.

C. The Work included in this Division consists of the furnishing of all labor, equipment, transportation, supplies, material and appurtenances and performing all operations necessary for the satisfactory installation of the complete and operating Communications System(s) indicated and/or specified in the Contract Documents.

D. Any materials, labor, equipment or services not mentioned specifically herein which may be necessary to complete or perfect any part of the Communications Systems in a substantial manner, in compliance with the requirements stated, implied or intended in the drawings and/or specifications, shall be included as part of this Contract.

E. The Contractor shall give written notice of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted a minimum of ten days prior to bid. In the absence of such written notice and by the act of submitting his bid, it shall be understood that the Contractor has included the cost of all required items in his bid, and that he will be responsible for the approved satisfactory functioning of the entire system without extra compensation.

F. It is not the intent of this Section of the Specifications (or the remainder of the Contract Documents) to make any specific Contractor, other than the Contractor holding the prime agreement, responsible to the Owner, Architect and Engineer. All transactions such as submittal of shop drawings, claims for extra costs, requests for equipment or materials substitution, shall be routed through the Contractor to the Architect (if applicable), then to the Engineer.

G. This Section of the Specifications or the arrangement of the Contract Documents shall not be construed as an attempt to arbitrarily assign responsibility of work, material, equipment or services to a particular Contractor or Sub-Contractor. Unless stated otherwise, the subdivision and assignment of work under the various sections shall be the responsibility of the Contractor holding the prime contract.

H. It is the intent of this Contract to deliver to the Owner a new and complete project once work is complete. Although plans and specifications are complete to the extent possible, it shall be the responsibility of the Contractors involved to remove and/or relocate or re-attach any existing or new systems which interfere with new equipment or materials required for the complete installation without additional cost to the Owner.

I. In general, and to the extent possible, all work shall be accomplished without interruption of facility operations. The Contractor shall advise the Architect, Owner and Engineer in writing at least one week prior to the deliberate interruption of any services. The Owner shall be advised of the exact time that interruption will occur and the length of time the interruption will last. Failure to comply with this requirement may result in complete work stoppage by the Contractors involved until a complete schedule of interruptions can be developed.

J. Whenever utilities are interrupted, either deliberately or accidentally, the Contractor shall work continuously to restore said service. The Contractor shall provide tools, materials, skilled journeymen of his own and other trades as necessary, premium time as needed and coordination with all applicable utilities, including payment of utility company charges (if any), all without requests for extra compensation to the Owner, except where otherwise provided for in the contract for the work.

1.06 DEFINITIONS

A. AHJ: Authorities Having Jurisdiction.

B. Architect: The Architect of Record for the project, if any.

C. Where this Section and other Sections of this Division use the term “Business Day” it shall mean Monday thru Friday, excluding Holidays recognized by Federal, State and Local government.

D. Contract Documents: All documents pertinent to the quality and quantity of all work to be performed on the project. Includes, but not limited to, plans, specifications, addenda, instructions to bidders (both General and Sub-Contractors), unit prices, shop drawings, field orders, change orders, cost breakdowns, construction manager’s assignments, architect’s supplemental instructions, periodical payment requests, etc.

1. Note: Any reference within these specifications to a specific entity, i.e. “Electrical Contractor” is not to be construed as an attempt to limit or define the scope of work for that entity or assign work to a specific trade or contracting entity. Such assignments of responsibility are the responsibility of the Contractor or Construction Manager holding the prime contract, unless otherwise provided herein.

E. Contractor: Any Contractor whether proposing or working independently or under the supervision of a General Contractor and/or Construction Manager and who installs any type of low-voltage communications work (Electrical, Low Voltage, Fire Alarm, etc.) or, the General Contractor.

F. Engineer: The Consulting Mechanical-Electrical Engineers either consulting to the Owner, Architect, other Engineers, etc.

G. ESS: Electronic Safety and Security

H. Furnish: Deliver to the site in good condition.

I. Install: Install equipment furnished by others in complete working order.

J. Provide: Furnish and install in complete working order.

K. RS-232: TIA standard for asynchronous serial data communications between terminal devices.

L. RS-485: TIA standard for multipoint communications using two twisted-pairs.

M. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.07 DRAWINGS AND SPECIFICATIONS

A. The Drawings are diagrammatic only and indicate the general arrangement of the systems and are to be followed insofar as possible. If deviations from the layouts are necessitated by field conditions, detailed layouts of the proposed departures shall be submitted to the Engineer for approval before proceeding with the work.

B. The Drawings and Specifications are intended to supplement each other. No Contractor shall take advantage of conflict between them, or between parts of either. This also includes potential conflicts with regards to equipment and material model numbers, part numbers, etc. and respective description and/or performance. Should this condition exist, the Contractor shall request a clarification not less than 10 days prior to the submission of the proposal so that the condition may be clarified by Addendum. In the event that such a condition arises after work is started, the interpretation of the Engineer shall be the determining factor. In all instances, unless modified in writing and agreed upon by all parties thereto, the Contract to accomplish the work shall be binding on the affected Contractor.

C. The Drawings and Specifications shall be considered to be cooperative and complimentary and anything appearing in the specifications which may not be indicated on the drawings or conversely, shall be considered as part of the Contract and must be executed the same as though indicated by both.

D. Contractor shall make all necessary and required measurements in the field and shall be responsible for correct fitting. The work shall be coordinated with all other branches of work in such a manner as to cause a minimum of conflict or delay.

E. The Engineer shall reserve the right to make adjustments in location of conduit, j-hooks, devices, etc. where such adjustments are in the interest of concealing work or presenting a better appearance. Unless a formal proposal request is issued, this work shall be performed without additional cost to the Owner.

F. Each Contractor shall evaluate ceiling heights called for on Architectural Plans. Where the location of Communications equipment may interfere with ceiling heights, the Contractor shall call this to the attention of the Engineer in writing prior to making the installation. Any such changes shall be anticipated and requested sufficiently in advance so as to not cause extra work on the part of the Contractor or unduly delay the work.

G. Should conflict or overlap (duplication) of work between the various trades become evident, this shall be called to the attention of the Engineer. In such event neither trade shall assume to be relieved of the work which is specified under his branch until instructions in writing are received from the Engineer.

H. The Drawings are intended to show the approximate locations of equipment, materials, devices, etc. Dimensions given in figures on the drawings shall take precedence over scaled dimensions and all dimensions, whether given in figures or scaled, shall be verified in the field to ensure no conflict with other work. In case of conflict between small- and large-scale drawings, the larger scale drawings shall take precedence.

I. Where on the Drawings a portion of the work is drawn out and the remainder is indicated in outline, or not indicated at all, the parts drawn out shall apply to all other like portions of the work. Where ornamentation or other detail is indicated by starting only, such detail shall be continued throughout the courses or parts in which it occurs and shall also apply to all other similar parts of the work, unless otherwise indicated.

J. Details not usually shown or specified, but necessary for the proper installation and operation of systems, equipment, materials, etc., shall be included in the work without additional cost to the Owner, the same as if herein specified or indicated.

K. Where on the Drawings or Addenda the word “typical” is used, it shall mean that the work method or means indicated as typical shall be repeated in and each time it occurs whether indicated or not.

1.08 SUBSTITUTION PROCEDURES

A. Comply with provisions of Division 01 Section “Substitution Procedures”.

B. Substitution may be considered when a product becomes unavailable through no fault of the Contractor.

C. If an alternate material is proposed that is equal to or exceeds specified requirements, Contractor shall provide manufacturers’ specifications in writing for Owner approval prior to purchase and installation.

D. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

E. Substitutions of material by the Contractor shall be in writing complete with written manufacturers’ specifications. The material substituted shall not void, alter or change manufacturers’ structured cabling system warranty.

F. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.

G. The Owner will be the final judge of acceptability, with review by Engineer and the distribution of the acceptance by the Architect.
   1. No substitute shall be ordered, installed or utilized without the Architect’s prior written verification of acceptance from the Owner.

1.09 QUALITY ASSURANCE

A. Regulatory Requirements

1. Contractor shall supply all city, county, and state telecommunication cabling permits required by appropriate governing agency.
2. Contractor shall be state-licensed and/or bonded as required for low voltage structured cabling systems.

B. Certifications
1. Contractor shall submit an up-to-date and valid certification verifying qualifications of the Contractor and installers to perform the work specified herein at time of bid submission.
2. Contractor shall have a complete working knowledge of low voltage cabling applications such as, but not limited to data, voice and video network systems.
3. Contracting firm shall have installed similar-sized systems in at least ten (10) other projects in the last five (5) years prior to this bid and be regularly engaged in the business of installation of the types of systems specified in this document.
    a. Certification shall include, but not be limited to, items such as name and location of project contacts and numbers, total square footage, total number of cables/drops, types of media, etc.
4. Contractor shall provide certificates for the appropriate insurance coverage as defined in contract documents.
5. All installer personnel that will be assigned to this project shall be listed in the qualification questionnaire document.
6. 80% shall have a minimum of three (3) years' experience in the installation of the types of systems, equipment, and cables specified in this document prior to this bid.
    a. Any personnel substitutions shall be noted in writing to Owner prior to commencement of work.
7. Contractor shall submit evidence of compliance with these requirements prior to beginning work on the project.
8. Cabling installers shall be trained and certified by the cable manufacturer for telecommunication cabling installations and maintenance of said materials.
9. Maintain current status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project. Staff each installation crew with the appropriate number of trained personnel, in accordance with their manufacturer/warranty contract agreement, to support the lifetime system warranty requirements. After installation, submit all documentation to support the warranty in accordance with the manufacturer's warranty requirements, including test results, and to apply for said warranty on behalf of the customer. The system warranty will cover the components and labor associated with the repair/replacement of any failed link as a result of a defective product when a valid warranty claim is submitted within the warranty period.

C. Administrative Requirements and Coordination requirements
1. Coordinate work of this section with Owner's telephone system specifications, workstations, equipment suppliers, and installers.
2. Coordinate installation work with other crafts (examples include ceiling grid contractors, HVAC and sheet metal contractors, etc) to resolve procedures and installation placement for cable trays and cable bundle pathways.
    a. The goal of this coordination will be to establish priority pathways for critical data/voice network cable infrastructure, materials, associated hardware, as well as mitigate delays to the project and to allow service access for communications and HVAC components.
    b. Damage by Contractor to the craft work of others will be remedied at the Contractor's expense in a timely manner.
3. Exchange information and agree on details of equipment arrangements and installation interfaces.
    a. Record agreements reached in meetings and distribute record to other participants, Owner and telecommunication consultant.

4. Adjust arrangement and locations of distribution frames, patch panels, and cross-connect blocks in equipment rooms and racks to accommodate and optimize arrangement and space requirements of any service provider equipment, telephone system, and LAN equipment.
    a. Tasks shall be coordinated with Owner or his representative, and other trades' installation representatives.
5. When requested by Owner or Owner's representative, furnish extra materials that match specified products and that are factory packaged with protective covering for storage and identified with labels describing contents.

D. Common Requirements for Material Quality: Materials, equipment and devices shall be new and of the quality specified and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment or devices identical with those damaged, unless approved otherwise by the Owner in writing.

E. Common Requirements for Code Compliance: In case where differences occur between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. Perform the following:
1. Promptly notify the Architect in writing of any such difference.
2. Obtain approval from Architect before proceeding with the Work.
3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations; the Work shall be corrected at no cost to the Owner.

F. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:
1. Promptly notify the Architect in writing of any such difference.
2. Obtain approval from Architect before proceeding with the Work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Coordination with delivery companies, drivers, site address, and contact person(s) will be the responsibility of the Contractor.

B. Contractor requirements:
1. Be responsible for prompt material deliveries to meet contracted completion date.
2. Coordinate deliveries and submittals with the General Contractor to ensure a timely installation.
3. No equipment materials shall be delivered to the job site more than three weeks prior to the commencement of its installation.
4. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
5. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
6. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants.
    a. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
7. Contractor shall be responsible for all handling and control of equipment. Contractor is liable for any material loss due to delivery and storage problems.

C. Owner/General Contractor shall supply a list of security requirements for Contractor to follow.

1.11 PROJECT/SITE CONDITIONS

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Contractor will remove burrs, dirt, and construction debris.
   1. If applicable, the Contractor will repair damaged finishes, including chips, scratches, and abrasions.

B. Contractor shall provide daily a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Contractor shall keep all liquids (drinks, sodas, etc.) off finished floors, carpets, and tiles.
   1. If any liquid or other detriment (cuts, soils, stains, etc.) damages the above finishes, Contractor shall provide professional services to clean or repair scratched/soiled finishes, at Contractor's expense.

1.12 COORDINATION

A. In describing various materials, equipment and devices, in general each item may be described singularly, even though there may be a multiplicity of identical items. Also, where the description is general in nature, the exact sizes, duties, space arrangements, and other requirements must be obtained by reference to other portions of Contract Documents.

B. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer. Verify that all materials, equipment and devices proposed for use on this Project are within the constraints of the allocated space.

C. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping" and in this Section.

F. Roof-Mounted Equipment: Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.13 WARRANTY

A. Contractor shall provide a minimum one (1) year warranty on installation and workmanship.

1.14 MAINTENANCE

A. Support Availability: The Contractor shall commit to make available local support for the product and system during the Warranty or Extended Warranty periods.

PART 2 PRODUCTS

2.01 IDENTIFICATION (LABELING) SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Brady
   2. Brother
   3. Dymo
   4. Hellerman-Tyton

2.02 FIRESTOP SYSTEMS

A. General:

1. Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
2. Provide components for each through-penetration firestop system that are needed to install fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

B. Manufacturers: Subject to compliance with requirements and with through-penetration firestop systems listed in Volume 2 of the UL Fire Resistance Directory, provide products by Specified Technologies, Inc. (STI) or Engineer approved equal.

C. Materials:
1. Firestop Sealants: Single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
a. STI SpecSeal Series SSS Sealant.
b. STI SpecSeal Series LCI Sealant.
2. Firestop Putty: Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
a. STI SpecSeal Series SSP Putty.
3. Firestop Pillows: Re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
a. STI SpecSeal Series SSB Pillows.
4. Fire-Rated Cable Grommet: Molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall. The following products are acceptable:
a. STI EZ-Firestop Grommets.
5. Fire-Rated Cable Pathways: Device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
a. STI EZ-PATH Fire Rated Pathway.

2.03 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.
1. Minimum Metal Thickness:
a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.01 CABLING SYSTEM INSTALLATION

A. For devices utilizing copper horizontal structured cabling, refer to Division 27 section Communications Copper Horizontal Cabling for requirements. In the event of a conflict, the more stringent standard shall apply.

B. Allowable Cable Bend Radius and Pull Tension:
   1. In general, ESS system cable cannot tolerate sharp bends or excessive pull tension during installation.
   2. Refer to cable manufacturer's bend radius recommendations for the maximum allowable limits.
   3. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue. Use only lubricants specifically designed for cable installation.

C. Pull Strings:
   1. Horizontal cable requirements
      a. Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.
      b. Pull string shall have a rated average breaking strength of 200 lbs.
      c. Data and video cables can be pulled in tandem with pull strings.
      d. During pulling sessions, pull strings must move freely to prevent cable jacket/cable damage.

D. Conduit Fill: Reference manufacturer's Design Installation Guidelines manual.

E. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

F. Expansion Capability: Unless otherwise indicated, provide spare conductor pairs in cables, positions in patch panels, cross connects, and terminal strips, and space in cable pathways and backboard layouts to accommodate 20% future increase in campus distribution and active workstations.

G. In the event of a breach of the representations and warranties contained herein, the Contractor, at their own expense, shall take all measures necessary to make the cabling system work and comply with the applicable manufacturer written technical recommendations and standards.

H. Owner’s technical representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling to inspect the method of cable routing and support and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate compliance with manufacturer’s minimum bend radius, and that cable ends are dressed neatly and orderly, etc.

3.02 EXAMINATION

A. Field Measurements
   1. Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on shop drawings.
   2. Coordinate fabrication schedule with construction progress to avoid delaying the work.

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

3.03 PREPARATION

A. Contractor’s RCDD shall review, approve and stamp all Shop Drawings, Submittal Documents, Coordination Drawings and As Built Drawings.

B. Pre-Installation Inspection:
   1. Contractor shall visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport.

2. Visibly damaged goods are not acceptable and shall be replaced by the Contractor at no additional cost to the Owner.

3.04 LABELING

A. Cable labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

B. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric cable designations.

C. Provide transparent plastic label holders, and 4-pair marked colored labels.

D. Install colored labels according to the type of field as per ANSI/TIA 606-A color code designations.

E. Use ANSI/TIA 606-A: “designation strip color-code guidelines for voice, data, cross- connect, riser, and backbone fields”

3.05 CODES, RULES, PERMITS, FEES, INSPECTIONS, REGULATION, ETC.

A. Contractor shall give all necessary notices, obtain and pay for all permits, government sales taxes, fees, inspections and other costs, including all utility connections, meters, meter settings, extensions, etc. in connection with his work.

B. Contractor shall file all necessary plans, utility easement requests and drawings, survey information on line locations, load calculations, etc. prepare all documents and obtain all necessary approvals of all utility and governmental departments having jurisdiction; obtain all certificates of inspection for his work and deliver same to the Engineer before request for acceptance and final payment for the work.

C. Ignorance of Codes, Rules, Regulations, Laws, etc. shall not render the Contractor irresponsible for compliance. The Contractor shall be versed in all Codes, Rules and Regulations pertinent to the work prior to submission of a proposal.

D. Contractor shall include in the work, without extra cost, any labor, materials, services, apparatus and drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether or not indicated or specified.

E. Where minimum code requirements are exceeded in the Design, the Design shall govern.

F. Ensure that the work is accomplished in accordance with the OSHA Standards and any other applicable government requirements.

G. All work relating to the handicapped shall be in accord with regulations currently enforced by the Authority Having Jurisdiction.

H. Where conflict arises between any code and the plans and/or specifications, the code shall apply except in the instance where the plans and specifications exceed the requirements of the code. Any changes required as a result of these conflicts shall be brought to the attention of the Engineer at least ten working days prior to bid date, otherwise the Contractor shall make the required changes at his own expense. The provisions of the codes constitute minimum standards for wiring methods, materials, equipment and construction and compliance therewith will be required for all electrical work, except where the drawings and specifications require better materials, equipment, and construction than these minimum standards, in which case the drawings and specifications shall be the minimum standards.

3.06 CUTTING AND PATCHING

A. Unless otherwise indicated or specified, each Contractor shall provide cutting and patching necessary to install the work specified in this Division. Patching shall match adjacent surfaces to the satisfaction of the Engineer and shall be in accord with the Architect's standards for such work, as applicable.

B. Each Contractor shall be responsible for all openings, sleeves, trenches, etc. that he may require in floors, roofs, ceilings, walls, etc. and shall coordinate all such work with the General Contractor and all other trades. Contractor shall coordinate with the General Contractor any openings which he is to provide before submitting a bid proposal in order to avoid conflict and disagreement during construction. Improperly located openings shall be reworked at the expense of the responsible Contractor.

C. Each Contractor shall plan his work ahead and shall place sleeves, frames or forms through all walls, floors and ceilings during the initial construction, where it is necessary for conduit, conductors, wireways, etc. to go through; however, when this is not done, this Contractor shall do all cutting and patching as well as reinforcement required for the installation of his work, or he shall pay other trades for doing this work when so directed by the Engineer. Any damage caused to the buildings by the workmen of the responsible Contractor must be corrected or rectified by him at his own expense.

D. Cut holes in casework, equipment panels, etc. (if any), as required to pass pipes in and out.

E. Notify other trades in due time where openings of chases in new concrete or masonry are required. Set all concrete inserts and sleeves for work. Failing to do this, cut openings for work and patch same as required at own expense.

F. Openings in slabs and walls shall be cut with core drill. Hammer devices will not be permitted. Edges of trenches and large openings shall be scribe cut with a masonry saw.

G. No structural members shall be cut without the approval of the Structural Engineer and all such cutting shall be done in a manner directed by him.

H. Each Contractor shall be responsible for properly shoring, bracing, supporting, etc. any existing and/or new construction to guard against cracking, settling, collapsing, displacing or weakening while openings are being made. Any damage occurring to the existing and/or new structures, due to failure to exercise proper precautions or due to action of the elements, shall be promptly and properly made good to the satisfaction of the Engineer.

I. All work improperly done or not done at all as required by the Communications trades in this section will be performed by the General Contractor at the direction of the Contractor whose work is affected. The cost of this work shall be paid for by the Contractor responsible.

3.07 SLEEVES AND PLATES

A. Provide and locate all sleeves and inserts required for work before the floors and walls are built, or be responsible for the cost of cutting and patching required where sleeves and inserts were not installed, or where incorrectly located. Each Contractor shall do all drilling required for the installation of his hangers. Drilling of anchor holes may be prohibited in post-tensioned concrete construction, in which case the Contractor shall request approved methods from the Architect and shall carefully coordinate setting of inserts, etc., with the Structural Engineer and/or Architect.

B. Galvanized steel sleeves shall be provided for all communications conduit passing thru concrete floor slabs and concrete, masonry, tile and gypsum wall construction.

C. Cast iron sleeves shall be installed through all walls where pipe enters the building below grade. Sleeves shall be flush with each face of the wall and shall be sufficiently larger than the entering pipe to permit thorough caulking with lead and oakum between pipe and sleeve for waterproofing.

D. In all cases, sleeves shall be at least two pipe sizes larger than nominal pipe diameter.

E. Where conduit motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe. Check floor and wall construction finishes to determine proper length of sleeves for various locations; make actual lengths to suit the following:

1. Terminate sleeves flush with walls, partitions and ceiling.
2. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
3. In all areas where pipes are exposed, extend sleeves ½ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 3/4 inches above floor.

F. Sleeves shall be constructed of 24-gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings.

G. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction occurs around them. Take precautions to prevent concrete, plaster or other materials being forced into the space between pipe and sleeve during construction. Fire and smoke stop all sleeves in a manner approved by the local authority having jurisdiction or per prevailing codes.

H. Sleeves passing through exterior wall (none are permitted thru roof) or where there is a possibility of water leakage and damage shall be caulked water tight for horizontal sleeves and flashed and counter-flashed with lead (4 lb.) or copper and soldered to the piping, lapped over sleeve and properly weather sealed. All roof penetrations shall be made inside mechanical equipment curbs.

I. All rectangular or special shaped openings in plaster, stucco or similar materials including gypsum board shall be framed by means of plaster frames, casing beads, wood or metal angle members as required. The intent of this requirements is to provide smooth even termination of wall, floor and ceiling finishes as well as to provide a fastening means for lighting fixtures, panels, etc. Lintels shall be provided where indicated over all openings in bearing walls, etc.

3.08 WEATHERPROOFING

A. Where any work pierces waterproofing, including waterproof concrete, the method of installation shall be as approved by the Architect and/or Engineer before work is done. Furnish all necessary sleeves, caulking and flashing required to make openings absolutely watertight.

B. Wherever work penetrates roofing, it shall be done in a manner that will not diminish or void the roofing guarantee or warranty in any way. Coordinate all such work with the roofing installer.

3.09 FIRESTOPPING

A. Refer to Division 07 Section “Firestopping” for additional requirements.

B. Preparation:
1. Examination of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
4. Do not proceed until unsatisfactory conditions have been corrected.

C. Through-Penetration Firestop System Installation:
1. Install through-penetration firestop systems in accordance with the conditions of testing and classification as specified in the published design.
2. Comply with manufacturer’s instructions for installation of through-penetration firestop systems products.
3. Seal all openings or voids made by penetrations to ensure an air and water resistant seal.
4. Protect materials from damage on surfaces subjected to traffic.

D. Do not penetrate rated fire walls, ceilings or floors with conduit, cable, wireway or other raceway system unless all penetrations are protected in a code compliant manner which maintains the fire-rating of the assembly. Firestop all openings made in walls, chases, ceilings and floors. Patch all openings around conduit, wireway, etc., with appropriate type material to provide needed fire rating at fire walls, ceilings and floors. Fire proofing materials and method of application shall be approved by the local authority having jurisdiction.

E. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly.

F. Apply putty pads to boxes located in fire-rated wall assemblies in which a horizontal distance of greater than 24” between boxes is not maintained.

G. Install and seal penetrations (conduit, sleeves, slots, chases) into or through fire-rated barriers created by or made for or on the behalf of the Contractor to prevent the passage of smoke, fire, toxic gas, or water through the penetrations.

H. Coordinate firestopping procedures and materials with General Contractor.

I. Solutions and shop drawings/submittals for firestop materials and systems shall be presented to the General Contractor for written approval of materials/systems prior to purchase and installation.

J. Following the pathway of others through compliant and non-compliant penetrations does not remove the requirement to maintain code-compliant firestopping.

K. Supply Owner with training manuals with instructions on methods of adding or removing cabling to/from firestopped sleeves and chases.

L. Provide manufacturer recommended material for rated protection for any given barrier.

M. Laminate and permanently affix adjacent to chases the following information:
   1. Manufacturer of firestop system
   2. Date of installation/repair.
   3. Part and model numbers of system and all components
   4. Name and phone numbers of local distributor and manufacturer’s corporate headquarters

N. The material chosen shall be distinctively colored to be clearly distinguishable from other materials, adhere to itself, and maintain the characteristics for which it is designed to allow for the removal and/or addition of communication cables without the necessity of drilling holes in the material.

3.10 TESTING

A. Upon completion of the communications infrastructure systems, including all pathways and grounding, the Contractor shall test the system.
   1. Cables and termination modules shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
   2. Any removal and reinstallation of any component in a circuit, including faceplates, shall require retesting of that circuit and any other disturbed or affected circuits.
   3. Cable/jack shall be affixed, mounted or installed to the designed/specified permanent location prior to testing.
      a. Any removal and reinstallation of any component in the circuit shall require retesting of that circuit.
   4. Approved instruments, apparatus, services, and qualified personnel shall be utilized.
   5. If tests fail, Contractor shall correct as required to produce a legitimate passing test.
   6. Manipulation of tester parameters on a failing test in order to achieve a passing test is unacceptable.

7. If the Contractor is found to have manipulated or falsified any failing test result to show a “PASS” for any reason (without written notice and prior approval of the Owner), the Contractor shall be required to employ a Third-Party Testing Agent selected by the Owner to retest the complete cable plant and shall be required to pay all costs associated with this retesting.

B. These specifications will be strictly enforced.
   1. The Contractor must verify that the requirements of the specifications are fully met through testing with an approved tester (rated for testing parameters listed elsewhere), and documentation as specified below.
   2. This includes confirmation of requirements by demonstration, testing and inspection. Demonstration shall be provided at final walk-through in soft copy and printed test data.

C. Notification of the likelihood of a cable exceeding standardized lengths must be made prior to installation of the cable.
   1. Without contractor’s prior written notice and written approval by the Owner, testing that shows some or all pairs of cable not meeting specifications, shall be replaced at Contractor’s expense (including respective connectors).
   2. With the Owner’s written approval, the over-length cable(s) shall be excluded from requirements to pass standardized tests and shall be explicitly identified.

D. Testing is still required for non-compliant cabling.
   1. The tests shall be for wire-mapping, opens, cable-pair shorts, and shorts-to- ground.
   2. The test results must be within acceptable tolerances and shall be submitted with the Owner’s acceptance document.

E. Contractor will complete all work and documentation according to manufacturer guidelines to ensure manufacturer’s warranty remains in effect.
   1. Contractor shall obtain certificates from manufacturer attesting to warranty being in effect and include certificates with other deliverables due at the completion of the project.

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

3.11 SCAFFOLDING, RIGGING AND HOISTING

A. Furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any equipment and apparatus furnished. Remove same from premises when no longer required in strict accordance with OSHA Guidelines.

3.12 OPTION TO RELOCATE DEVICES

A. The location of voice and data outlets and other similar devices along with their associated connections may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to rough-in or installation.

3.13 CLEANING

A. Work areas will be kept in a broom clean condition throughout the duration of the installation process.

B. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

C. The Contractor will damp clean all surfaces prior to final acceptance by Owner.

D. After completion of all work and before final acceptance of the work, thoroughly clean all equipment and materials and remove all foreign matter such as grease, dirt, plaster, labels, stickers, etc., from the exterior of equipment, fixtures and all other associated or adjacent fabrication.

3.14 ACCEPTANCE

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

B. Contractor must warrant in writing that 100% of the installation meets the requirements specified herein (Standards Compliance & Test Requirements).

C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation soft and hard copies as describe herein.

3.15 INDEMNIFICATION

A. The Contractor shall hold harmless and indemnify the Engineer, employees, officers, agents and consultants from all claims, loss, damage, actions, causes of actions, expense and/or liability resulting from, brought for, or on account of any personal injury or property damage received or sustained by any person, persons, (including third parties), or any property growing out of, occurring, or attributable to any work performed under or related to this contract, resulting in whole or in part from the negligence of the Contractor, any subcontractor, any employee, agent or representative.

3.16 HAZARDOUS MATERIALS

A. Any worker, occupant, visitor, inspector, etc., who encounters any material of whose content they are not certain shall promptly report the existence and location of that material to the Contractor and/or Owner. The Contractor shall, as a part of his work, insure that his workers are aware of this potential and what they are to do in the event of suspicion. He shall also keep uninformed persons from the premises during construction. Furthermore, the Contractor shall insure that no one comes near to or in contact with any such material or fumes therefrom until its content can be ascertained to be non-hazardous.

B. CMTA, Inc., Consulting Engineers, have no expertise in the determination of the presence of hazardous materials. Therefore, no attempt has been made by them to identify the existence or location of any such material. Furthermore, CMTA nor any affiliate thereof will neither offer nor make any recommendations relative to the removal, handling or disposal of such material.

C. If the work interfaces, connects or relates in any way with or to existing components which contain or bear any hazardous material, asbestos being one, then, it shall be the Contractor's sole responsibility to contact the Owner and so advise him immediately.

D. The Contractor by execution of the contract for any work and/or by the accomplishment of any work thereby agrees to bring no claim relative to hazardous materials for negligence, breach of contract, indemnity, or any other such item against CMTA, its principals, employees, agents or consultants. Also, the Contractor further agrees to defend, indemnify and hold CMTA, its principals, employees, agents and consultants, harmless from any such related claims which may be brought by any subcontractors, suppliers or any other third parties.

END OF SECTION

SECTION 28 0503
ELECTRONIC SAFETY AND SECURITY SHOP DRAWINGS AND SUBMITTALS

PART 1 GENERAL

1.01 SHOP DRAWINGS

A. Each Contractor shall submit to the Architect and/or Engineer, within thirty days after the date of the Contract, sets of shop drawings and/or manufacturer's descriptive literature (coordinate exact quantity with architectural specifications) on all equipment required for the fulfillment of his contract. Each shop drawing and/or manufacturer's descriptive literature shall have proper notation indicated on it and shall be clearly referenced per the specifications and/or schedules, etc., so that the Architect and/or Engineer may readily determine the particular item the Contractor proposes to furnish. All data and information scheduled, noted or specified by hand shall be noted in color red on the submittals. The Contractor shall make any corrections or changes required and shall resubmit for final review as requested. Review of such drawings, descriptive literature and/or schedules shall not relieve the Contractor from responsibility for deviation from drawings or specifications unless they have, in writing, directed the reviewer's attention to such deviations at the time of submission of drawings, literature and manuals; nor shall it relieve them from responsibility for errors or omissions of any nature in shop drawings, literature and manuals. The term "as specified" will not be accepted.

B. If the Contractor fails to comply with the requirements set forth above, the Architect and/or Engineer shall have the option of selecting any or all items listed in the specifications or on the drawings, and the Contractor will be required to provide all materials in accordance with this list.

C. Review of shop drawings by the Engineer applies only to conformance with the design concept of the project and general compliance with the information given in the contract documents. In all cases, the installing Contractor alone shall be responsible for furnishing the proper quantity of equipment and/or materials required, for seeing that all equipment fits the available space in a satisfactory manner and that piping, electrical and all other connections are suitably located.

D. The Engineer's review of shop drawings, schedules, product data or other required submittal data shall not relieve the Contractor from responsibility for the adaptability of the equipment or materials to the project, compliance with applicable codes, rules, regulations, information that pertains to fabrication and installation, dimensions and quantities, electrical characteristics, and coordination of the work with all other trades involved in this project.

E. No cutting, fitting, rough-in, connections, etc., shall be accomplished until reviewed equipment shop drawings are in the hands of the Contractors concerned. It shall be each Contractor's responsibility to obtain reviewed shop drawings and to make all connections, etc. in the neatest and most workmanlike manner possible. Each Contractor shall coordinate with all the other Contractors having any connections, roughing-in, etc., to the equipment, to make certain proper fit, space coordination, voltage and phase relationships are accomplished.

F. In accord with the provisions specified hereinbefore, shop drawings, descriptive literature and schedules shall be submitted on each of the following indicated items as well as any equipment or systems deemed necessary by the Engineer:
   1. Raceways:
      a. Conduit (each type).
      b. Bridle ring assembly.
      c. J-hook assembly.
      d. Junction, pull, and device boxes
   2. Systems: Each system submittal is to be complete with legible cutsheets for all devices, equipment, special wiring, etc. Also, provide scaled building layout drawings that indicate device placement, wiring, etc. Refer to the specific system's specification for additional submittal requirements where required.
      a. Access Control System

b. Intrusion Detection System
c. Fire Alarm System
d. Emergency Responder Radio Antenna System

3. Miscellaneous
   a. Control panel assemblies.
   b. Non-standard junction/pullboxes

G. Specification Compliance Certification: Where this Section and other Sections of this Division require Specification Compliance Certification to be submitted, comply with the following:
   1. Prepare a line-by-line Specification Compliance Certification by marking up a copy of the Contract Document specification section in the left margin. Accompany the markup with a written report explaining all items that are not marked with “Compliance”. Submit line-by-line markup, written report of deviations and alternates and a cover letter certified by Manufacturer or Installer that prepared the Specification Compliance Certification. Use the following key for preparing the line-by-line markup.
      a. “C” for Compliance: By noting the term "compliance" or "C" in the margin, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
      b. “D” for Deviation: By noting the term "deviation" or "D" in the margin, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified.
      c. “A” for Alternate: By noting the term "alternate" or "A" in the margin, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner.
      d. “N/A” for Not Applicable: By noting the term “not applicable” or “N/A” in the margin, it shall be understood that the specified item is not applicable to the project.

1.02 SPECIAL WRENCHES, TOOLS AND KEYS

A. Each Contractor shall provide, along with the equipment provided, any special wrenches or tools necessary to dismantle or service equipment or appliances installed by him. Wrenches shall include necessary keys, handles and operators for valves, switches, etc. and keys to alarm pull boxes, panels, etc. At least two of any such special wrench, keys, etc. shall be turned over to the Architect prior to completion of the project. Obtain a receipt that this has been accomplished and forward a copy to the Engineer.

1.03 FIRE ALARM SHOP DRAWINGS

A. The Contractor and equipment supplier shall submit to the Architect and/or Engineer, fire alarm system shop drawings complete with catalog cuts, descriptive literature and complete system wiring diagrams for their review prior to submittal to the Authority Having Jurisdiction for their review.

1.04 MAINTENANCE AND OPERATION MANUALS

A. Upon substantial completion of the project, the Electrical Contractor shall deliver to the Engineers (in addition to the required Shop Drawings) three complete copies of operation and maintenance instructions and parts lists for all equipment provided. These documents shall at least include:
   1. Detailed operating instructions.
   2. Detailed maintenance instructions including preventive maintenance schedules.
   3. Addresses and phone numbers indicating where parts may be purchased.
   4. Reference architectural specifications for additional requirements.

B. Refer to individual Contract Document specification sections for additional requirements.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 28 0510
SCOPE OF THE ELECTRONIC SAFETY AND SECURITY WORK

PART 1 GENERAL

1.01 SUMMARY

A. Each Communications Contractor's attention is directed to Division 28 Section “Common Electronic Safety and Security Requirements” and all other Contract Documents as they apply to his work.

1.02 SCOPE

A. The Electronic Safety and Security Work for this Project includes all labor, materials, equipment, devices, and related items required to completely install, test, place in service and deliver to the Owner complete safety and security systems in accordance with the accompanying plans and all provisions of these specifications. This work shall primarily include, but is not limited to the following:
   1. All j-hooks, fittings, etc. – Coordinate with Division 26.
   2. All wiring devices and device plates.
   3. All system hardware, equipment and installation.
   4. All programming, scheduling and testing.

B. Grounding, per NEC and the specified requirements.

C. All necessary fees and cost for permits, inspections, etc.

D. Coordination with Division 21 for interface with fire suppression systems.

E. Coordination with Division 23 for interface with HVAC systems and building instrumentation and control system.

F. Coordination with Division 26 for power, rough-in, conduit and cable pathways.

G. Coordination with Division 27 for low voltage structured cabling systems.

H. Access control system as indicated.

I. Intrusion detection system as indicated.

J. Emergency responder radio antenna system as indicated.

K. Fire alarm system as indicated.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 28 0539
EMERGENCY RESPONDER RADIO ANTENNA SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Design, furnish, install, and test a complete and operating in-building Emergency Responder Radio Antenna System (ERRAS) for the new elementary school to provide complete coverage for the public safety agencies as required by the local fire department and the authority having jurisdiction (AHJ). The system will support only the emergency responder radio system and no others. Provisions for supporting other cell phone carriers, Wi-Fi signals, and the Owner's private security and/or maintenance radio systems shall not be included.

B. This Section includes the minimum indoor signal levels, signal level verification testing, system design, plan submittal requirements, and system acceptance for an Emergency Responder Radio Antenna System (ERRAS) installed in accordance with IFC 510.

C. This Section includes the requirements for an ERRAS for the purposes of amplifying emergency responder radio signals to achieve minimum signal strength in 95 percent of all areas on each floor of the building. Provide all equipment, materials, labor, supervision and services necessary for or incidental to the installation of a complete ERRAS.

D. It shall be the responsibility of the Emergency Responder Radio Antenna System Contractor to obtain all required permits, approvals and certifications from the AHJ. All fees associated with the licensing shall be paid by the Contractor.

E. Final acceptance and approval are required from the local AHJ in writing prior to contract closeout.

F. Section Includes:
   1. Bi-directional amplifiers (BDA's).
   2. Distributed antenna system.
   3. Coaxial cables.
   4. Splitters and direction couplers.
   5. Battery Back-Up System or UPS.
   6. All other equipment and components necessary for a complete and functioning Emergency Responder Radio Antenna System.

G. Related Sections include the following:
   1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
   2. Division 28 Section "Digital Addressable Voice Evacuation Fire Alarm System" for interface of Emergency Responder Radio Antenna System with the fire alarm system.

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. Attenuation: The reduction in signal power, expressed in decibels (dB), as a result of coupling, heat loss, or transmission distance in a cable or in air.

C. BDA: Bi-Directional Amplifier. Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station for enhanced signals and improved coverage.

D. CBC: Coupled Bonding Conductor. A bonding conductor placed on the outside of any technology cable used to suppress transient noise.

E. DAQ: Delivered Audio Quality Definitions. This is a universal standard often cited in systems designs and specifications.
   1. DAQ 1: Unusable, speech present but not intelligible.

2. DAQ 2: Understandable with considerable effort. Frequent repetition due to noise and/or distortion.
3. DAQ 3: Speech understandable with slight effort. Occasional repetition required due to noise and/or distortion.
4. DAQ 3.5: Speech understandable with repetition only rarely required. Some noise and/or distortion.
5. DAQ 4: Speech easily understood. Occasional noise and/or distortion.
6. DAQ 4.5: Speech easily understood. Infrequent noise and/or distortion.
7. DAQ 5: Speech easily understood.

F. DAS: Distributed Antenna System. A network of service antennas connected at intervals along shielded coaxial transmission lines and all connected to head-end electronics amplifying the signals to be distributed. Often refers to a system that includes both the passive distribution system and the active amplifying electronics.

G. Directional Coupler. A component which directs a small portion of downstream RF energy to a port which can be connected to an antenna or another branch of distribution cabling, and also serves as a combiner of upstream energy between the tap port and through the connection port.

H. Donor Antenna: The antenna, usually mounted on the outside of a structure where a DAS is installed, which picks up signals over-the-air from a donor service.

I. Donor Source: The repeater, transceiver, cell site, or other radio site that produces signals which a DAS will relay and distribute.

J. ERRAS: Emergency Responder Radio Antenna System. A two-way radio communication system installed to assure the effective operation and coverage of radio communications systems for fire, emergency medical services and/or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.

K. EMT: Electrical Metallic Tubing.

L. FCC: Federal Communications Commission. Federal agency responsible for implementing and enforcing America's communications laws and regulations.

M. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

N. Public Safety/First Responder: Agencies which are charged with the responsibility of responding to emergency situations. These include, but are not limited to, law enforcement department, fire departments, and emergency medical companies.

O. Reflected Power: Power which is reflected back along a transmission line as a result of discontinuities in line impedance caused at connectors or close proximity of metallic objects.

P. RF: Radio Frequency. Energy from electromagnetic waves, or alternating currents that produce electromagnetic waves, in the spectrum of radio frequencies 30 kHz to 300 GHz.

Q. Splitter: A passive component that has a single input port and two or more output ports, effectively splitting the signal equally amongst the output ports. It also serves to combine upstream signals from the "output" ports into composite signals at the "input" port.

1.03 REGULATIONS

A. Codes, regulations and standards referenced in this Section include:
1. NFPA 1: The National Fire Code (including Annex O from 2009)
2. NFPA 70: The National Electrical Code
3. NFPA 72: The National Fire Alarm Code
4. NFPA 101: The Life Safety Code

5. NFPA 1221: Standard for the Installation, Maintenance and Use of Emergency Services Communication Systems
6. UL 2524: First Edition In-Building Two-Way Emergency Radio Communication Enhancement Systems
7. IFC 510: International Fire Code, Emergency Responder Radio Coverage
8. FCC 47 CFR: Private Land Mobile Radio
9. FCC 47 90.219-2007: Services-Use of Signal Boosters
10. FCC Rules Part 22, Part 90 and Part 101
11. FCC OET 65 Standards: Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields
12. ADA: Americans with Disabilities Act

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of proposed system component specified, including dimensioned drawings showing minimum clearances and installed features.
   1. Provide copies of manufacturer specification sheets of all system components including:
      a. Amplifiers
      b. Antennas
      c. Coaxial cable, couplers, splitters, combiners, or other passive components
      d. Backup battery and charging system with run time specifications
   2. Submit product certificates signed by the manufacturer of radio system components certifying that their products comply with specified requirements.
   3. Contractor and manufacturer shall supply sufficient information to indicate the proposed system is based on the latest hardware, software technology and products and complies with specified requirements and FCC regulations.
   4. An indication of any deviations from Contract Documents requirements, including variations and limitations. Show any revisions to equipment layout required by use of selected equipment.
   5. A product data index and complete equipment list including each product submitted for approval with the manufacturer’s name, part number and any included options or selections.

D. Shop Drawings:
   1. Submit shop drawings locating all components of the system indicating circuit routing, cable type, and gauge. Include information that will allow the Contractor to coordinate interdisciplinary work and when necessary guide the manufacturer or fabricator in producing the product.
   2. Include elevation detail names for each elevation view. Sheet title shall include site name, address, sheet number, floor plan number and north arrow. Include site plan view of the subject buildings and surrounding property to clearly indicate the location and orientation of roof mounted outdoor antennas associated with the proposed system.
   3. Include a minimum of one (1) building elevation depicting the location of any outdoor antenna associated with the proposed system. Include height of antenna centerline above building, orientation, and location of all external grounding connections.

4. Include a detail plan view of all IT rooms housing head-end and/or other consolidated equipment, showing the location of the rack(s) and/or enclosure(s) of the ERRAS equipment.
5. Include a separate plan view of each interior floor where indoor antenna systems are proposed. Include antenna numbers, coaxial cable routes, and the locations of any other system components including splitters, couplers, filters, amplifiers, etc. All component shall be named or labeled for reference in power budget calculations tables. Overlay approximated coverage radii indicating -95 dBm downlink (base to mobile) signal strength around each proposed indoor coverage antenna. Include results of any previous coverage testing per grid, if available.
6. Include a minimum of one (1) detail elevation view(s) of all rack(s) and/or enclosure(s) housing the ERRAS equipment. Identify each piece of equipment by brand, model number and equipment type.
7. Specify antenna grounding and surge protection in accordance with NEC Article 810.
8. Specify the back-up power source (Life Safety), and include calculations to ensure the back-up power requirements as specified in this standard are met.

E. Wiring Diagrams:
1. Submit wiring diagrams from manufacturer differentiating clearly between factory and field-installed wiring. Include diagrams for each component of the system with all terminals and interconnections identified. Make all diagrams specific to this Project.

F. Ambient Signal Level Measurements: For all proposed systems utilizing broadband amplification schemes, including bi-directional amplifiers, ambient signal levels measurements for nearby carriers (800 MHz consideration) in the adjacent SMR and cellular bands must be provided. This will ensure the amplifier will not be overdriven and create harmful interface.
1. A maximum amplitude plot (“Max Hold”) of signal strength (dBm) vs. frequency (MHz), between 863 MHz and 880 MHz. Perform measurement for at least ten (10) minutes during the hours of 7 AM – 7 PM, Monday through Friday.
2. Resolution Bandwidth shall be 10 KHz.
3. Place markers on any carrier measured over -55 dBm to readily identify signal strength and frequency. No more than three (3) markers are required.
4. Place one (1) marker on the active City/County 800 MHz control channel(s).
5. All plans shall be submitted electronically in a radio propagation format.

G. General Submittal Requirements:
1. Submittals shall be approved by AHJ prior to submitting them to Architect and Engineer.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.
1. Copies of FCC Licenses for both the Designer and Project Manager.
2. Letter from manufacturer stating that the Contractor is an Authorized Factory Distributor for the area where Project is located.
3. The system described in the submittals shall be certified by an FCC Licensed Designer and installation shall be supervised by an FCC Licensed Project Manager.

B. Field quality-control reports.

C. Testing reports.
1. Submit all field test records of the ERRAS. These shall include, but not be limited to:
a. Preconstruction Tests: Tests performed with the AHJ prior to construction of the new facility to verify that the municipality has signal coverage in that area.
b. Mid-Construction Tests: Tests performed with the AJH during construction, once walls have been constructed and the exterior roof and glazing is installed.

c. Final Testing: Tests performed in conforming with IFC Section 51 0.5.3 and Section 51 0.6. This testing is to be signed off by the AHJ. Engineers shall also be present for the final testing process.

2. All testing records shall be submitted with operations and maintenance information and close out documents.

D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For radio systems and components to include in emergency, operation, and maintenance manuals.
1. Include data for each type of product, including all features and operating sequences, both automatic and manual.
2. Provide names, addresses, and telephone numbers of service organizations that carry stock of repair parts of the system to be furnished.
3. Include record of field tests of the radio system.
4. Provide a parts list with manufacturer and model number for commonly replaced parts.
5. Include complete instructions for the inspection, testing, and maintenance of the system. Include copies of all calculation sheets used to configure the system.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced factory-authorized installer to perform work of this Section. The Contractor shall meet the following requirements:
1. As a business entity, shall be an authorized distributor and designated representative of the ERRAS manufacturer, with full warranty privileges, and shall have been actively engaged in the business of selling, installing, and servicing ERRAS for a period of at least five (5) years.
2. Employ factory trained technicians capable of supporting the maintenance of the system. No contract employees are allowed unless they have been to the factory service school within the last 18 months. A certificate of this training shall be provided with the Contractor's submittal.
3. Employ full time local technicians and installers. The manufacturer shall maintain a full-time factory employed service staff for product support and service.
4. Maintain an office within 150-miles of the job site, staffed with trained technicians who are qualified and licensed to supervise the installation, to be responsible that the system is installed as submitted, to conduct system start up and perform a 100 percent operational audit of all installed devices, to instruct the Owner's representatives in the proper operation of the system, and to provide service throughout the warranty period.
5. Fully experienced in the design and installation of the type of system herein specified and shall furnish with the contract proposal an itemized list of the installations of the type specified herein. The list shall include the name of the project, date of completion, the amount of the contract, the name and telephone number of a qualified person to contact for reference. This list must contain at least two (2) projects within a 150-mile radius of the school district to allow school administration officials to visit the job site for review of the system installation and service. Each reference project listed must utilize equipment by the same manufacturer as the proposed system.
6. Not have any grievances or complaints of record regarding workmanship, code compliance, or service response. A Contractor that has any prior finding(s) of a code or license violation or has any litigation in process concerning the installation of a system is unacceptable.

B. Source Limitations for Radio System and Components: Obtain radio system components from a single source who assumes responsibility for compatibility of system components.

C. Radio Components, Devices, and Accessories: All equipment shall be UL listed and labeled and in accordance with applicable NEMA and ANSI Standards. Where copper cabling is routed to an area, either in another building, or with a separate electrical service, the Technology Contractor shall provide primary protective equipment.

D. 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.

E. All racks and enclosures shall be either welded or assembled with paint piercing ground washers, grounding strip and bonding jumper.

1.08 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace radio system equipment and components that fail in materials or workmanship within specified warranty period.
   1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
   2. Any equipment, cabling or wiring shown to be defective shall be replaced, repaired, or adjusted free of charge.
   3. All labor and materials shall be provided at no expense to the Owner.
   4. Warranty Period: One (1) year from date of Substantial Completion.

B. Immediately prior to the end of the warranty period, the system shall be inspected and certified for the following year at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available integrators offering products that may be incorporated in the work include, but are not limited to:
   1. ADRF
   2. Axell Wireless.
   3. Farenhyt by Honeywell.
   4. Gamewell-FCI by Honeywell.
   5. Notifier by Honeywell.
   6. SOLiD Technologies, Alliance Corporation.
   7. Tessco.
   8. Times Microwave.

2.02 GENERAL PERFORMANCE REQUIREMENTS

A. Compatibility: The equipment, including but not limited to repeaters, transmitters, receivers, signal boosters, cabling, fiber distributed antenna system, etc., shall not interfere with the existing communication systems utilized by the Public Safety and First Responder agencies.

B. Power Supplies: At least two (2) independent and reliable power supplies shall be provided, one primary and one secondary. The primary power source shall be supplied from a dedicated 20 ampere branch circuit and comply with 4.4.1.4 of NFPA 72. The secondary power source shall be a dedicated battery, capable of operating with in-building radio system for at least 24 hours of 100 percent system operation. The battery system shall automatically charge in the presence of external power input. The battery system shall be contained in one NEMA 4 or 4X type enclosure. Monitoring the integrity of power supplies shall be in accordance with 4.4.7.3 or NFPA 72.

C. Survivability:
   1. Physical Protection: All wiring and fiber optics shall be installed in conduit. Refer to Division 26 Section “Raceways and Boxes for Electrical Systems” for type, sizing and installation standards.

2. Fire Performance: All main risers or trunks of the antenna system shall be installed with resistance to attack from a fire using one of the following methods:
   a. A 2-hour fire rated cable or cable system.
   b. Routing the cable through a 2-hour fire rated enclosure(s) or shaft(s).
   c. System configured in a looped design, routing through 1-hour fire rated enclosure(s) or shaft(s). The circuit shall be capable of transmitting and receiving a signal during a single open or non-simultaneous single ground fault on a circuit conductor.
   d. Performance alternative approved by the authority having jurisdiction.
3. Cabinet: The signal booster and all associated RF filters shall be housed in a single, NEMA 4 certified, painted steel weather tight box. The cabinet shall be large enough to dissipate internal heat without venting the inside of the cabinet to the outside atmosphere.
4. Operating Temperatures: -22 degrees F to +120 degrees F minimum temperature range, including microprocessors. Equipment installed on the roof of structures shall be rated for the expected extreme temperatures associated with rooftop installations.
5. Rooftop installations shall require a pitch pocket for proper weathertight roof penetrations.
6. Passive Equipment: Passband shall be 700-900 MHz, IP rating of 2 GHz.
7. Cable: Passband shall be 700-900 MHz. Cable shall be rated for fire plenum and riser rating.

2.03 SYSTEM COMPONENTS

A. Signal Strength:
   1. Downlink or Inbound Signal: A minimum signal strength of -95 dBm and a DAQ of 3.5 shall be receivable throughout 95 percent of the building. In critical areas, the signal coverage should be receivable over 99 percent of the critical areas such as, command center(s), fire pump rooms, stairs, elevator lobbies, and sectional valve locations or others as defined by the AHJ.
   2. Uplink or Outbound Signal: Minimum signal strength of -95 dBm received at the local Fire Department Radio System from the coverage area.
   3. Isolation: A donor antenna must maintain isolation from the distributed antenna system. The donor antenna signal level shall be a minimum of 15 dB above the distributed antenna system under all operating conditions.

B. Permissible Systems:
   1. Buildings and structures shall be equipped with an FCC Certificated Class B Bi-Directional Amplifier(s) as needed.
   2. The distributed antenna system may utilize a radiating cable, fixed antennas or a combination of both.
   3. Bi-directional amplifiers shall be FCC Certified and registered prior to installation.

C. Supported Frequencies: The radio system shall support VHF, UHF, and frequencies in the 700 and 900 MHz as required for local public safety and first responder bands as utilized by the local municipality.

D. Reject Filters: Notch filter sections shall be incorporated to minimize adjacent channel cellular and SMR degradation of the signal booster performance. The minimum downlink band adjacent band rejection shall be 35 dB or greater at 865 MHz and 870 MHz.

E. Band Migration Capability: The signal booster shall include re-tunable or replaceable filters to accommodate rapid and economic passband changes in the event of mandatory FCC changes within the NPSPAC band. The use of non-adjustable and non-replaceable RF input and output filters is prohibited.

F. Output Level Control: An automatic output leveling circuit shall be included for both passbands with a minimum dynamic range of 60 dB, less any gain reduction setting, to maintain FCC out of band and spurious emission compliance.

G. Degraded Performance in Emergencies: The system shall be designed to allow degraded performance in adverse conditions, such as abnormally high temperatures resulting from nearby fires, extreme voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. over/under voltage, over/under current, over/under temperature, etc.) will not be implemented as the standard mode for public safety applications.

H. Mode of Operation: The system shall be normally powered on and shall continuously provide passing of frequencies within the Public Safety and First Responder bands.

I. All in-building radio systems shall be compatible with both analog and digital communications simultaneously at the time of installation.

2.04 SYSTEM MONITORING

A. The ERRAS shall include a connection to the fire alarm system. The ERRAS shall include automatic supervisory and trouble signals for malfunctions of the signal booster(s) and power supply(ies) that are annunciated by the fire alarm system and comply with the following:
   1. The integrity of the circuit monitoring signal booster(s) and power supply(ies) shall comply with NFPA 72. Coordinate and provide this integration, as part of this system, with the fire alarm system contractor that is authorized to service the facility's fire alarm system.
   2. System and signal booster(s) supervisory signal shall include the following:
      a. Antenna malfunction
      b. Signal booster failure
   3. Power supply supervisory signals shall include the following for each signal booster:
      a. Loss of normal ac power
      b. Failure of battery charger
      c. Low battery capacity, alarming at 70 percent of battery capacity.
   4. Any resulting trouble alarm shall be automatically transmitted to an approved central station or proprietary supervising station as defined in NFPA 72 and shall sound an audible signal at a constantly attended location.

B. A sign shall be located at the fire alarm panel with the name and telephone number of the local Fire Department indicating that they shall be notified of any failures that extend past the 2-hour time limit.

C. A dedicated supervised monitoring panel shall be provided at a location designated by the AHJ inside the facility to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
   1. Normal AC power
   2. Signal booster trouble
   3. Antenna failure
   4. Loss of normal AC power
   5. Failure of battery charger
   6. Low battery capacity

2.05 PERMIT REQUIRED

A. A permit must be obtained prior to the construction or modification of an ERRAS as required by IFC 510 and the AHJ and must also be approved by the Emergency Radio Communication Division. A copy of the permit shall be posted visibly on the main active component, or at the point of primary system operation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Distribution System Signal Wires and Cables:
1. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.
2. Wires or cables routed between consoles, cabinets, racks, and other equipment shall be installed in an approved conduit or cable tray that is secured to building structure.
3. Cable pathways, conduit, and cable support systems shall be complete with bushings, deburred, cleaned, and secure prior to installation of cable.
4. Before energizing the system, completely test all cables after installation and replace any that are found to be defective. Test for short circuits, ground faults, continuity, and insulation.
5. Install cables without damaging conductors, shield, or jacket.
6. Do not bend cables, while handling or installing, to radii smaller than as recommended by manufacturer.
7. Pull cables without exceeding cable manufacturer’s recommended pulling tensions. Any pulling compounds utilized must be approved by the cable manufacturer.
8. In all exposed ceiling areas such as mechanical rooms, cable shall be fully enclosed in conduit.
9. Cable must not be fastened to electrical conduits, mechanical ductwork or piping, sprinkler piping, or routed to obstruct access to hatches, doors, utility access panels, or service work areas. Do not route cables through fire doors, ventilation shafts, grates, or parallel for more than four-feet with line voltage electrical conductors. System cables shall not be run loose on ceiling grid or ceiling tiles.
10. Each cable run shall be free of splices. No terminations, splices, or equipment will be installed in or above ceilings.
11. Do not route any communication cable within two feet of any light fixture, HVAC unit, service access area, electrical panel, or any device containing a motor or transformer.

B. System Installation:
1. Coaxial antenna cabling shall not be installed in the same conduit, raceway, or cable trays used for other systems.
2. All equipment shall be connected according to the OEM’s specifications to ensure correct installation and system performance.
3. Coordinate all roof penetrations with Owner and/or roofing contractor.

C. Non-Interference
1. No radio signal amplifications system capable of operating on frequencies or causing interference on frequencies assigned to the jurisdiction by the FCC shall be installed without prior coordination and approval from the AHJ. The Owner shall suspend and correct other equipment installations that de-grade the performance of the ERRA.

3.03 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials from damage during handling and installation.

3.04 LICENSING

A. All fees associated with the licensing shall be paid by the Owner.

B. All testing must be done on frequencies authorized by the FCC.

3.05 GROUNDING

A. Ground cable shields and equipment per Manufacturer's requirements.

B. Antenna mast shall be grounded per NFPA 70 NEC requirements, Division 27 Section "Grounding and Bonding of Communications Systems", and antenna manufacturer's requirements.

C. Provide grounding blocks and surge protection for outside coaxial cabling.

D. Bond the antenna mast to the lightning protection system (if applicable).

3.06 FIELD QUALITY CONTROL

A. The local AHJ will review plans and specifications. Upon acceptance, plans will be stamped to indicate approval. Stamped plans are required to be present at the acceptance test. Any field changes that occur during construction shall be incorporated into new As-Built plans, including any manufacturer's data sheets for any equipment changes not submitted in the original submittal. As-Built plans, if required due to system changes, shall be submitted to the local AHJ for approval.

B. Tests shall be made using frequencies close to the frequencies used by the Fire Department and appropriate emergency services. If testing is done on the actual frequencies, then this testing must be coordinated with the local Fire Department unit. All testing must be done on frequencies authorized by the FCC. A valid FCC license will be required if testing is done on frequencies different from the police, fire or emergency medical frequencies.

C. Field tests shall be witnessed by the AHJ.

D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

E. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed As-Built Drawings and system documentation.
   2. Testing Procedures:
      a. Testing of the system shall conform to the testing requirements as described in the International Fire Code (IFC) Section 51 0.5.3.
      b. All testing must be done on frequencies authorized by the FCC and in use by local agencies as directed by the AHJ.
      c. Each floor of the building shall be divided into a grid of approximately 20 equal grid areas of a minimum of 20 feet and a maximum of 80 feet per grid to a maximum of 128,000 sf per level. For floors with more than 128,000 sf per floor, it will require that it be divided into grid sectors of no more than 20 grids per sector and tested individually per sector.
      d. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the delivered audio quality (DAQ) system. A DAQ level below 3.5 shall be considered a failed test for a given grid cell.

e. Measurements shall be made with the antenna held in a vertical position at 3 to 4 feet above the floor to simulate a typical portable radio worn on the belt or turnout coat pocket.
f. All measurements shall be made in an averaged mode with sampling minimums as specified below:
    1) Average signal levels shall be recorded while walking an “X” pattern with the center of the pattern located approximately in the center of each grid area.
    2) The linear distance of each side of the “X” shall be 10 percent of the length of the grid’s side, and a minimum length of 10 feet. At least one sample per each five feet traveled shall be recorded, and no less than five samples per measurement recorded.
    3) A test location approximately in the center of each grid area will be selected for the test, then the radio will be enabled to verify two-way communications to and from the outside of the building through the public safety agency’s radio communications system. Once the test location has been selected, prospecting for a better spot within the grid area will not be permitted.
    4) A maximum of two nonadjacent areas will be allowed to fail the test. A failure occurs when the measured signal level falls below the minimums specified above.
g. Thoroughly test all components of the systems and devices proposed herein to assure equipment specifications are met. This contractor will start up, test, and debug systems to ensure that all aspects of the system are working, documented, and reporting properly.
h. Active components shall be tested to establish initial system gains of equal value to those of design criteria. During subsequent inspections, gain values shall be measured to ensure values equal to those at time of final acceptance.

3. Final Acceptance Testing:
    a. All acceptance testing shall be done in the presence of a local AHJ representative and the Owner.
    b. Small scale drawings (11-inch x 17-inch) of the structure shall be provided by the Contractor to the Owner. The plans shall show each floor divided into the grids as described above, and the results of the pre-testing. Each grid shall be labeled to indicate the DAQ result from the final acceptance testing.
    c. The Contractor shall provide the latest approved plans for the system, including any manufacturer’s data sheets for any equipment changes not submitted in the original submittal to the Owner.
    d. Include testing results of the repeater (output wattage, gain level, etc.) and connection to the fire alarm.

F. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

G. Radio system will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

I. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

J. Annual Test and Inspection: One year after date of Substantial Completion, test radio system. Use forms developed for initial tests and inspections.

3.07 ANNUAL TESTING

A. Annual tests shall be the Owner’s responsibility. All live components of the system, such as signal boosters, power supplies, and backup batteries shall be tested at a minimum of once every 12 months. Owner shall maintain documentation at the request of the AHJ.

1. The re-testing will be done at no expense to the AHJ or the appropriate emergency services departments as required in the original testing procedures.

B. All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Telephone Operator License, or a technician certification issued by the Association of Public-Safety Communications Officials International (APCO) or equivalent as determined by the local Fire Marshal.

C. Fire Department Radio personnel, after providing reasonable notice to the Owner or their representative, shall have the right to enter onto the property to conduct field testing to be certain that the required level of radio coverage is present.

3.08 SERVICE MAINTENANCE CONTRACT

A. Provide a maintenance contract with a Radio Service Provider with name of authorized company, who will provide a 24-hour by 7-day emergency response within two (2) hours after notification. The system shall be maintained in accordance with FCC requirements. The contract shall be for five (5) years.

B. Maintain a list of contact personnel with phone numbers at the radio repeater system cabinet. The contact personnel shall have knowledge of the building and the repeater system and be available to respond to the building in the case of an emergency.

C. Radio Service Provider maintenance contract shall include but not be limited to the following:
   1. Annual Test:
      a. All active components of the distributed antenna system, including but not limited to amplifier, power supplies, and back-up batteries, shall be tested a minimum of once every 12 months.
      b. Amplifiers shall be tested to ensure that the gain is the same as it was upon initial installation and acceptance. The original gain shall be noted and any change in gain shall be documented.
      c. Back-up batteries and power supplies shall be tested under load for a period of 1 hour to verify that they will operate during an actual power outage.
      d. Active components shall be checked to determine that they are operating within the manufacturer's specifications for their intended purpose.
      e. Documentation of the test shall be maintained on site and a copy forwarded to the local Fire Department Radio Supervisor upon completion of the test.

3.09 TRAINING

A. On-site training sessions shall be conducted by the ERRAS Contractor. It shall be the responsibility of the Contractor to coordinate time and location of training sessions with the Owner. Provide documented general instruction as follows:
   1. Provide instructions to the maintenance personnel to include the location, inspection, normal maintenance, testing and operation of all system components. Provide a minimum of four (4) hours, two (2) 2-hour sessions separated by a minimum of two (2) weeks.
   2. Provide instruction to designated personnel on the functions and operation of the system provided including capabilities, limitations, and the meaning of status messages. State the proper procedure for testing, routine maintenance, and request for service. Provide detailed instruction on the operation of the system. Provide a minimum of four (4) hours, two (2) 2-hour sessions separated by a minimum of two (2) weeks.

END OF SECTION

SECTION 28 1300
ACCESS CONTROL SOFTWARE AND DATABASE MANGEMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. New access control software and database management shall integrate into Owner's existing Vanderbilt Security Management access control system used throughout the district. Provide all necessary servers, controllers, licenses and appurtenances for a complete functioning system.

B. Section Includes:
   1. Security access operating system and application software.
   2. Security access controllers connected to high-speed electronic-data transmission network.

C. Related Requirements:
   1. Division 27 Section "Intercommunications and Program Systems" for automated emergency messages and/or tones to be broadcast during an emergency lockdown sequence.
   2. Division 28 Section "Access Control System Hardware Devices" for access control system hardware, such as card readers, credential cards, and networked hardwired electronic locks.

1.03 SCOPE

A. This document includes a general description, functional requirements, operational characteristics, and criteria for the Access Control and Security Management System (ACSMS). The ACSMS shall be a product of a single manufacturer.

B. Furnish and install a complete microprocessor-based ACSMS as specified herein. The system shall include, but not be limited to, all control equipment, power supplies, power circuits, signal initiating and signaling devices, conduit, wire, network cabling, fittings, and all other accessories required to provide a complete and operable system.

C. The installing contractor shall design and provide a complete system, meeting the requirements of these specifications. Provide all security system devices required for a complete system perimeter coverage acceptable to all governing authorities, Architect, Engineer, and Owner.

D. Conduct a pre-construction meeting with Owner's personnel, installing technician, project superintendent, and Engineer prior to the start of any construction.

E. Connect this Project location to the district monitoring station as designated by the Owner.

F. Additional responsibilities of the ACSMS Contractor are as follows:
   1. Input all access control doors, door position switches, door release buttons, and all other devices into ACSMS mapping feature.
   2. Mapping feature shall be programmed for complete monitoring of all devices as well as complete functionality of doors. Features shall include but not be limited to:
      a. Lock
      b. Unlock
      c. Lockdown
      d. Position
      e. Alarm for propped door

3. Provide integration for Video Management System for this Project. All door and camera integrations shall be reviewed with Owner prior to programming. Provide all required video client licenses integrated with the camera recording system per campus.

1.04 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a workstation-to-controller communications link, with additional controllers at the Location connected to the workstation-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. Workstation: Personal computer. Applies to the central station, workstations, and file servers.

F. RAS: Remote access services.

G. RF: Radio frequency.

H. ROM: Read-only memory. ROM data are maintained through losses of power.

I. TCP/IP: Transport control protocol/Internet protocol.

J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

K. WMP: Windows media player.

L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Indicate system components, wiring diagrams, and load calculations.
   2. System labeling schedules, including electronic copy of labeling schedules.
   3. Wiring Diagrams: For power, signal, and control wiring, show typical wiring schematics.
   4. Cable Administration Drawings: As specified in "Identification" Article.
   5. Battery and charger calculations for controllers.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Contract Close-Out Submittals: Provide one (1) electronic format manual including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
   1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
   2. Hardware Manual: The manual shall describe all equipment furnished including:
      a. General description and specifications.
      b. Installation and check out procedures.
      c. Equipment layout and electrical schematics to the component level.
      d. System layout drawings and schematics.
      e. Alignment and calibration procedures.
      f. Manufacturers repair parts list indicating sources of supply.
   3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
      a. Definition of terms and functions.
      b. System use and application software.
      c. Initialization, start up, and shut down.
      d. Reports generation.
      e. Details on forms customization and field parameters.

C. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.08 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum of five (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.
   1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

B. Supplier Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum of three (3) years of experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.

1. Schlage access control products are required to be supplied only through designated “Authorized Channel Partners.”

C. System Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum of three (3) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:
   1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
   2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
   3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
   4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.

D. Installer Qualifications:
   1. Certified technicians, verifiably authorized with the primary product manufacturers for installation of IP-Enabled, Wireless, and Power-over-Ethernet Access Control products in accordance with documented instructions and NFPA 80.
   2. The installer shall be the authorized representative of the Access Control Manufacturer to sell, install, and service the proposed manufacturer’s product for at least three (3) years.
   3. The installer must have Vanderbilt Security Management System training certification from the manufacturer. No person is allowed to work on the system without proper manufacturer’s certification.
   4. The installer shall provide 24-hour, 365-day per year emergency service with factory trained service technicians.
   5. The installer shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.

E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
   2. Provide integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
   3. Networked, hardwired electronic locks are required to be supplied and installed only through designated Allegion partners and certified integrators.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packaging. Store and handle in accordance with the manufacturer’s requirements.
   1. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.

1.10 WARRANTY

A. Warranty Period: The entire system shall be warranted against defects in materials and workmanship for a period of one (1) year from date of Substantial Completion including labor.

B. ACSMS Software and Field Hardware Warranty:
   1. ACSMS Software shall be warranted for a period of 90 Days from the date of shipment from the manufacturer to be free of defects and will function in substantial accordance to the published specification.
   2. ACSMS Field Hardware shall be warranted for a period of three (3) years from the date of Substantial Completion, will be free from defects and will function in general accordance with the product specifications.

C. ACSMS Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to the owner. Specific third-party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the ACSMS field hardware or computers and are purchased directly from the ACSMS manufacturer. Examples may include but not be limited to; Credential Printers, Reader Heads, Computers etc..

PART 2 PRODUCTS

2.01 ACCESS CONTROL SOFTWARE

A. Manufacturer: Open Options.

2.02 GENERAL REQUIREMENTS

A. The Access Control and Security Management System (ACSMS) shall be a highly scalable, robust access control and security management system developed using the latest in development technology. The ACSMS shall provide a singular interface capable of controlling multiple, geographically independent sites and provide alarm monitoring, video management integration, ID badging, personnel and cardholder management, and situational control of all connected devices from a single application.

B. The ACSMS must fully support the Authentic Mercury Security Corporation controllers and sub-controllers.

C. The ACSMS must support credential readers that communicate via RS-485.

D. The ACSMS must support the Open Supervised Device Protocol (OSDP).

E. A sufficient number of controllers and sub-controllers will be provided to monitor all credential reader, monitor point, and relay point locations shown on plan.

2.03 FEATURES

A. Multi-User/Network Capabilities: The ACSMS shall support multiple operator workstations via local area network/wide area network (LAN/WAN). The communications between the workstations and the server computer shall utilize the TCP/IP standard over industry standard IEEE 802.3 (Ethernet). The communications between the server and workstations shall be supervised, and shall provide the ability to generate alarm messages when the server is unable to communicate with a workstation.

B. Operating Environment: The ACSMS shall be a 3-tier client/server, ODBC compliant application based on Microsoft tools and standards. The ACSMS application shall operate in the following environments: Windows 10 Enterprise/Professional. Windows Server 2016 and 2019.

C. Multi-level Password Protection: The ACSMS application shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The application shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete.

D. NT Authentication: The ACSMS application will support the implementation of NT authentication, thereby utilizing the credentials supplied by the network administrator to authenticate during the login process of the system.

E. Strong Password Enforcement: The ACSMS application shall have an option to enforce strong passwords and by setting minimum character lengths and complexity requirements.

F. Graphical User Interface: The ACSMS shall be fully compliant with Microsoft Graphical User Interface (GUI) standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system configuration.

G. Concurrent Licensing: The ACSMS shall support concurrent client workstation licensing. The ACSMS application shall be installed on any number of client workstations, and shall provide the ability for any of the client workstations to connect to the application server as long as the maximum number of concurrent connections purchased has not been exceeded.

H. Access Control Software Suite: The ACSMS shall be a scalable application such that there is no requirement for separate tiers or editions of software. The same code set used for smaller, more localized installations, shall be the same code set used for enterprise system deployments.

I. System Partitioning/Filtering: The ACSMS shall provide the option to restrict access to personnel and hardware data based on login and profile.

J. Encryption: The ACSMS shall provide multiple levels of data encryption.
   1. Must support 128-bit or 256-bit AES data encryption between the host and intelligent controllers. The encryption shall ensure data integrity that is compliant with the requirements of FIPS-197 and SCIF environments. Master keys shall be downloaded to the intelligent controller, which shall then be authenticated through the Access Control and Security Management System based on a successful match.
   2. Transparent database encryption, including log files and backups.
   3. SQL secure connections via SSL.

K. Industry Standard Panel Communication: The ACSMS shall communicate with the access control intelligent controllers via LAN/WAN connections utilizing industry standard communication protocols.

L. Supervised Alarm Points: The ACSMS shall provide both supervised and non-supervised alarm point monitoring with the ability to specify custom values of resistance. On recognition of an alarm, the ACSMS shall be capable of switching and displaying the video from the camera connected to the video management system that is associated with the alarm point.

M. Multiple Account Support: The ACSMS shall allow support for multiple accounts allowing separate access to the personnel database, badge layout, operator access, and reporting. Physical hardware may be filtered by profile level into “sites”. “Sites” may be assigned to one or more operator profiles. The system shall allow control of common areas between operator profiles. Access levels and time schedules shall be global to allow for easy administration and filtering. The global access levels and time schedules shall be capable of being used by one or more operator profiles.

N. Camera Support: The ACSMS shall support, via integrated VMS platforms, pan, tilt, zoom, and touring features.

O. Display Live Video: The ACSMS shall support an option to view live video from a camera connected to an integrated VMS. The cameras from the integrated VMS shall be able to be associated with any hardware device programmed in the ACSMS and opened automatically on any system event or operator-initiated command sequence.

P. Global/Anti-Passback: The ACSMS shall support multiple modes of anti-passback, by which cardholders must follow a specified sequence of card reads in the configured areas.

Q. Alarm Events: The ACSMS shall include a feature where alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention.
   1. The pop-up shall display the following information:
      a. Description of the event.
      b. Time and date.
      c. Point description.
      d. If a card event, the card number.
      e. Type of event.
      f. Cardholder name.
   2. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgement or Clearing the event. Event instructions shall be made available by double clicking on the event.
   3. The Alarm shall display an icon to indicate that a camera is associated to the device.
   4. The Alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not be limited to:
      a. Acknowledge.
      b. Clear.
      c. Open a pre-programmed floor plan.
      d. Activate or de-activate.
      e. Pulse.
      f. Add comment.
      g. Retrieve archived video and bring up live video.
      h. Disarm or arm.

R. Global Device Control: The ACSMS shall allow manual control of one or more selected inputs, outputs, and doors. Global device control shall include pulse, timed pulse, and energize/de-energize or return to normal options for output points and arm/disarm or return to normal options for input points. For global control of doors, the ACSMS shall include Disabled, Unlocked, Locked, Facility Code Only, Card Only, PIN Only, Card and PIN, Override Mode, and Cancel Override Mode.

S. Global Edit: The ACSMS shall support, by way of a multi-select function, a method to globally edit input points, outpoint points, doors, readers, personnel and cards.

T. Levels of System Operation:
   1. The ACSMS shall include a feature to define the levels of system operation for each individual operator using passwords and profiles. System operation for individual operators shall include, but not be limited to:
      a. Restricted time periods for login.
      b. Inactivity notifications.
      c. Lockout for failed logon attempts.
   2. Operator actions range from:
      a. No view or control rights.
      b. Basic monitoring including the ability to block the viewing of card and/or personal identification numbers.
      c. Full control of the system including programming.

U. Distributed Processing: All the control components of the ACSMS shall utilize “Distributed-Processing” design. The distributed processing shall include the ability to download operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of the ACSMS application server.

2.04 FUNCTIONAL CAPABILITIES

A. All transactions and audits shall be logged by date and time to the database.

B. The end-user shall have the ability to make any system configuration changes such as, but not limited to door open time, door contact shunt time, point and door names, when and where a cardholder is authorized, and the ability to add or modify personnel records at any time and without assistance from the manufacturer or system installer.

C. Global Anti-pass Back: Allows cardholders to enter/exit any such defined card reader area on any intelligent control panel provided they follow the required in/out flow.

D. Duress PIN Feature: Configurable in operation by which the cardholder either adds a specified digit to their unique PIN or appends a specified digit to their unique PIN.

E. All updates and changes to the programming in the intelligent controllers shall take place real-time and will not require manual downloads to propagate system changes.

F. Available Application Program Interface (API): Built on current development technologies that allows the integration of third-party programs or systems.

G. Intuitive Graphical User Interface (GUI): An operator will not be required to close or switch views to another part of the application in order to edit or view any aspect of the system. The GUI must be fully customizable allowing for an infinite number of operator views to be created and assigned. The GUI must support drag and drop functions within the multi-document interface.
   1. The GUI shall be developed in such a manner that any place that a personnel record or hardware device is shown that an operator can right click on it and open the properties or execute control functions.

H. Global I/O Functions: Any point programmed in the system can be configured to control any other point on the system regardless of which intelligent controllers they reside on.

I. All necessary system drivers shall run as Windows services and as such do not require the Operating System to be logged in on the application server.

J. Support for thick client, web client and mobile client applications that provide system management functions.

K. Situation Level Manager: Provides five different states that can be initiated by clicking on a single, color coded button. The Situation Levels shall by configurable on the following objects: Doors, Time Schedules, Input Points, Output/Relay Points, and Credentials.

L. Direct Commands: Allow the creation of a single button to control a single or multiple devices simultaneously by clicking one button, based on operator privileges.
   1. Direct Commands shall be one of many ways to incorporate facility lockdowns and return to normal or all clear states.
   2. Direct Commands shall have the ability to password protect to require additional authentication prior to execution.

M. Remove From Service: Remove an input point from service, where by any change of state on that point is ignored, regardless of the point arm/disarm state. Removing a point from service goes beyond disarming the point, as it can be rearmed via a programmed or manual event, thereby reporting alarm conditions once again. A point that has been removed from service must be returned to service in order to see change of state events on it.

N. Override Modes on Doors: Current mode of the door can be overridden to another state. (i.e. Card Only, Card & PIN, Locked, Disabled). When the mode of door has been overridden, it will remain in that state, regardless of any scheduled commands or manual control initiated based on time or operator execution. When the override mode is canceled, the door will revert to the state that it is supposed to be in. For example, if a time schedule has activated to unlock the door, then it will revert to that state without any additional programming or intervention from the operator.

O. Removal from service and override modes must be selectable with the following options:
   1. Indefinite: The state will remain until it has been cancelled.
   2. For a specified number of minutes.
   3. Until a specific time of the current day.

2.05 PERSONNEL AND CARHOLDER MANAGEMENT

A. Provide a personnel browser method of managing personnel data in a hierarchical tree. The personnel browser shall be sortable by any field of data stored in the personnel record. Browser shall have ability to:
   1. Create unlimited custom personnel groups that personnel records can be assigned to where by personnel records can be assigned to one or more personnel groups.
   2. Assign default access levels to custom personnel groups that cardholders will inherit or disinherit as they are added or removed to or from custom personnel groups.
   3. Assign one or more credentials to a single personnel record.
   4. Support a maximum of 128 access levels per credential per intelligent controller.

B. Vacation Start Function: Allows the temporary disabling of cards for a specified number of days.

C. Temporary Upgrade of Access Levels: Operator can temporarily assign an access level with start and stop dates.

D. Situation Level: Any or all credentials activate or deactivate based on a system-controlled Situation Level.

2.06 INTEGRATED GRAPHICS MAPS

A. Provide an integrated graphical map module allowing for the importation of floor plans and other .JPG or .BMP files for use in plotting hardware and other connected devices programmed in the system onto the graphic layouts. This shall not require any additional licensing fees.

B. Assign a graphic map as a homepage of any point in the system, thereby linking that device to that map and allowing the system to automatically load the graphic upon an alarm condition from any pint that is plotted on it.

C. Hyperlink the graphic maps to one another thereby creating a “drill down” effect.

D. Create buttons on the graphic maps which can then be linked to Direct Commands.

2.07 INTEGRATED WIRELESS/INTELLIGENT LOCKS

A. System shall support wireless/intelligent AD-00 lock sets from Allegion/Schlage.
   1. Must support the following modes on the Allegion/Schlage locksets:
      a. Classroom.
      b. Privacy.
      c. Office.
   2. Must support Over the Network Re-Provisioning (ONR) of the firmware to the AD-300.

2.08 CONTROLLERS

A. Controllers: Intelligent peripheral control unit, complying with UL 294, that stores time, date, valid codes, access levels, and similar data downloaded from the central server for controlling its operation.

B. Battery Backup: Sealed, lead acid; sized to provide run time during a power outage of 90 minutes, complying with UL 924.
   1. Provide wall-mounted enclosures in quantities as required for Project.

C. Alarm Annunciation Controller:
   1. The controller shall automatically restore communication within 10 seconds after an interruption with the field device network.
      a. Inputs: Monitor dry contacts for changes of state that reflect alarm conditions. Provides at least eight alarm inputs, which are suitable for wiring as normally open or normally closed contacts for alarm conditions.
      b. Alarm-Line Supervision:
         1) Supervise the alarm lines by monitoring each circuit for changes or disturbances in the signal by monitoring for abnormal open, grounded, or shorted conditions using dc change measurements. System shall initiate an alarm in response to an abnormal current, which is a dc change of 5 percent or more for longer than 500 ms.
         2) Transmit alarm-line-supervision alarm to the central station during the next interrogation cycle after the abnormal current condition.
      c. Outputs: Managed by central-station software.

2.09 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to workstations, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.
   1. Record setup data for control station and workstations.
   2. For each Location, record setup of controller features and access requirements.
   3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
   4. Set up groups, facility codes, linking, and list inputs and outputs for each controller.
   5. Assign action message names and compose messages.
   6. Set up alarms. Establish interlocks between alarms and video surveillance features.
   7. Lockdown: Establish lockdown sequences and programming.
   8. Prepare and install alarm graphic maps.
   9. Develop user-defined fields.
   10. Develop screen layout formats.

11. Propose setups for guard tours and key control.
12. Discuss badge layout options; design badges.
13. Complete system diagnostics and operation verification.
14. Prepare a specific plan for system testing, startup, and demonstration.
15. Develop acceptance test concept and, on approval, develop specifics of the test.
16. Develop cable and asset-management system details; input data from construction documents. Include system schematics and Visio Technical Drawings in electronic format.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.03 IDENTIFICATION

A. Develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.
3. Provide violet-colored jacket on all access control cabling. Coordinate with Division 27 Section “Communications Copper Horizontal Cabling”.

C. At Project completion, cable and asset management documents shall reflect as-built conditions. Provide an electronic PDF overall plan of the school with access control door hardware locations marked in red.

3.04 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.05 LOCKDOWN SEQUENCES

A. Coordinate with Owner in programming and testing all lockdown sequences in the ACSMS. All sequences must be programmed and operational prior to Substantial Completion of Project.

B. Building Lockdown:
1. The Reception area shall be equipped with a local momentary pushbutton to initiate a building wide lock down sequence.
2. When initiated, all exterior doors shall be locked.
3. Release: The lockdown sequence shall only be released with a valid credential card scan from the lockdown release card reader in the Reception area.
4. Refer to Drawings for door locations and for additional sequence information.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.
1. Complete installation and startup checks according to approved procedures and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.07 PROTECTION

A. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employ of Contractor is not present.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the ACSMS equipment.

B. Provide a minimum of eight (8) hours of video recorded training for the Owner.

C. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Division 01 Section "Demonstration and Training."

D. Train Owner’s administration personnel at the school how to initiate remote door lock/unlock sequences and how to initiate and reset lockdown sequences.

E. Develop separate training modules for the following:
   1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
   2. Operators who prepare and input credentials to man the workstations and to enroll personnel.
   3. Security and hardware maintenance personnel.

END OF SECTION

SECTION 28 1500
ACCESS CONTROL HARDWARE DEVICES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Furnish and install electric door hardware, including:
   1. Networked, wired electric handlesets.

B. Furnish, install, and integrate Access Control System hardware including:
   1. Door wiring harnesses, electric power transfers, door cords, etc as needed for connection of door hardware to system.
   2. Door hardware power supplies
   3. Door controller hardware.
   4. Credential readers.
   5. Door release button(s).
   6. "Lockdown" button(s).

C. Related Requirements:
   1. Division 28 Section “Access Control Software and Database Management” for integration with access control software.

1.03 DEFINITIONS

A. Abbreviations
   1. API: Application Programming Interface
   2. IEC: International Electrotechnical Commission
   3. IEEE: Institute of Electrical and Electronics Engineers
   4. IKxx (where xx is a 2-character designation): Impact protection rating as defined by IEC 62262
   5. IP: Internet Protocol, an OSI Layer 3 communication protocol for interconnecting computer networks
   6. IPxx (where xx is a 2-character designation): Ingress protection as defined by IEC 60529.
   7. OSDP – Open Supervised Device Protocol, a standard for encrypted serial communication between credential reader and access control hardware system developed by SIA and published as IEC60839-11-5
   8. PoE – Power over Ethernet
   9. RF: Radio frequency.
   10. RFID: Radio frequency Identification, an identifier technology using near- or intermediate-field RF communication to communicate an Identifier between a Credential and the access control management system.
   11. TCP: Transmission Control Protocol, an OSI Layer 4 transport protocol.
   12. UDP: Uniform Datagram Protocol, an OSI Layer 4 transport protocol.
   13. Wi-Fi: Wireless Ethernet as defined by the IEEE 802.11 standards.

B. Credential: An object or device (such as an RFID card) which contains or embodies an Identifier and is assigned to an entity and used to identify that entity to the system.

C. Identifier: A unique number, biometric characteristic, cryptographic key, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Wiegand (Effect): Patented magnetic principle that uses specially treated wires embedded in the credential card.

E. Wiegand (Standard): Wiring and protocol specification for communication between credential reader and access control hardware system.

1.04 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.05 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Contract Close-Out Submittals: Provide one (1) electronic format manual including operating instructions, maintenance recommendations and parts list including wiring and connection diagrams modified to reflect as-built conditions.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual’s contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
2. Hardware Manual: The manual shall describe all equipment furnished including:
    a. General description and specifications.
    b. Installation and check out procedures.
    c. Equipment layout and electrical schematics to the component level.
    d. System layout drawings and schematics.
    e. Alignment and calibration procedures.
    f. Manufacturers repair parts list indicating sources of supply.
3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
    a. Definition of terms and functions.
    b. System use and application software.
    c. Initialization, start up, and shut down.
    d. Reports generation.

e. Details on forms customization and field parameters.

C. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.08 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum of five (5) years of documented experience in providing access control and security systems equipment and software similar to that indicated for this Project and that have a proven record of successful in-service performance.
   1. Software and access control systems components to have been previously and thoroughly tested together with proven installations similar in size and functionality to the design requirements indicated for this Project.

B. Supplier Qualifications: Supplier/Dealers, verifiably authorized and in good standing with the primary product manufacturers, with a minimum of three (3) years of experience supplying integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance.

C. System Integrator Qualifications: Systems Integrators, verifiably factory trained and certified by the primary product manufacturers, with a minimum of three (3) years documented experience installing complete integrated access control systems similar in material, design, and scope to that indicated for this Project and whose work has resulted in construction with a proven record of successful in-service performance. Qualifications include, but are not necessarily limited, to the following:
   1. References: Provide a list of references for similar projects including contact name, phone number, name and type of project.
   2. Professional Staffing: Firms to have a dedicated access control systems integration department with full time, experienced professionals on staff experienced in providing on site consulting services for both electrified door hardware and integrated access control systems installations.
   3. Factory Training: Installation and service technicians are to be competent factory trained and certified personnel capable of maintaining the system.
   4. Service Center: Firms to have a service center capable of providing training, in-stock parts, and emergency maintenance and repairs at the Project site with 24-hour/7-days a week maximum response time.

D. Installer Qualifications:
   1. Certified technicians, verifiably authorized with the primary product manufacturers for installation of IP-Enabled, Wireless, and Power-over-Ethernet Access Control products in accordance with documented instructions and NFPA 80.
   2. The installer shall be the authorized representative of the Access Control Manufacturer to sell, install, and service the proposed manufacturer’s product for at least three (3) years.
   3. The installer shall provide 24-hour, 365-day per year emergency service with factory trained service technicians.

4. The installer shall have personnel on their staff that has been actively engaged in the business of designing, selling, installing, and servicing security alarm systems for at least ten (10) years.

E. Source Limitations: Obtain the access control door hardware, system firmware and application software specified in this Section from a single source, qualified supplier/integrator unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
   2. Provide integrated access control door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.

B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.

D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
   1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
   2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
   3. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph.

1.11 WARRANTY

A. Warranty Period: The entire system shall be warranted against defects in materials and workmanship for a period of one (1) year from date of Substantial Completion including labor.

B. ACMS Software and Field Hardware Warranty:
   1. ACMS Field Hardware shall be warranted for a period of three (3) years from the date of Substantial Completion, will be free from defects and will function in general accordance with the product specifications.

2. ACSMS Third Party Device warranties are transferred from the manufacturer to the contractor, which may then transfer third party warranties to Owner. Specific third-party warranty details, terms and conditions, remedies and procedures, are either expressly stated on, or packaged with, or accompany such products. The warranty period may vary from product to product. These products include but are not limited to devices that are directly interconnected to the ACSMS field hardware or computers and are purchased directly from the ACSMS manufacturer. Examples may include but not be limited to; Credential Printers, Reader Heads, Computers etc.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

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 NFPA 70 , "National Electrical Code."

C. Comply with SIA DC-03 and SIA DC-07.

2.02 NETWORKED WIRED ELECTRONIC LOCKS

A. Manufacturers: Provide products by the following:
   1. Schlage AD-300 wired network electronic lock

B. Electronic lock shall communicate to door controller via an RS-485 interface.

C. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

D. Integrated reader shall support the credential cards as specified.

E. Provide function and trim as specified in door hardware drawings, schedules, and specifications. Refer to Division 08 Door Hardware Specifications for further requirements and information.

2.03 DOOR HARDWARE, CRASHBARS, ETC.

A. Manufacturers: Door hardware are to be as manufactured by:
   1. Allegion.

B. Refer to Division 8 Door Hardware Specifications for further information.

2.04 DOOR HARDWARE POWER SUPPLIES:

A. Provide power supply in wall-mounted NEMA-1 cabinet.

B. Accessories: Provide terminal block with eight fusible outputs and battery backup kit.

C. Power supplies to be located in technology closet serving each building area, with low-voltage cabling run from closet to door. No power supplies shall be installed above ceiling.

D. Power Supply Products: Subject to requirements, provide:
   1. Schlage PS-902, PS-904, or PS-906.

E. Battery Backup Products: Subject to requirements, provide:
   1. Schlage 900-BBK battery backup kit.

F. Fused Terminal Block: Subject to requirements, provide:
   1. Schlage #900-8F fused output terminal block.

   NO SUBSTITUTIONS except by written Owner approval.

2.05 DOOR CONTROLLER HARDWARE

A. Door controller hardware connects door hardware and credential readers to Owner’s access control system.

B. Controller Products: Subject to requirements, provide:
   1. Open Options SSP-D2 (Mercury LP1502).
      NO SUBSTITUTIONS except by written Owner approval.

C. Power Supply: Schlage PS902.

D. Provide double pole, double throw door position contacts at each exterior door or set of exterior double doors to monitor door position.
   1. George Risk Industries (GRI) #195-12 or equal.

E. Provide necessary licensing for each card reader-controlled door. Coordinate licensing with Owner.

2.06 CREDENTIALS: FOBS

A. Provide thin keyfob-type credential with 125kHz prox technology.

B. Products: Subject to requirements, provide:
   1. Schlage #7610T
      NO SUBSTITUTIONS except by Written Owner approval.

C. Provide five hundred (500) fobs for new campus.

2.07 PUSH-BUTTON SWITCHES

A. Manufacturers: Provide products by the following:
   1. Safety Technology International (STI) SS2 series.

B. Push-Button Switches: Momentary-contact push buttons with stainless steel backplate with colored polycarbonate cover.

C. Electrical Ratings:
   1. Minimum continuous current rating of 10A at 120-V ac.
   2. Contacts that will make 720 VA at 60A and that will break at 720 VA at 10A.
   3. Provide turn-to-reset option where required on Drawings.

D. Enclosures: Flush mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

E. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.08 CABLES

A. General Cable Requirements: Comply with requirements in Division 27 Section "Communications Copper Horizontal Cabling" and as recommended by system manufacturer for integration requirement.

B. Plenum-Rated TIA 485-A Cables:
   1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
   2. Fluorinated ethylene propylene insulation.
   3. Unshielded.
   4. Fluorinated ethylene propylene jacket.
   5. NFPA 70 Type: Type CMP
   6. Flame Resistance: NFPA 262, Flame Test.

C. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:
   1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
   2. NFPA 70, Type CMP.
   3. Flame Resistance: NFPA 262 flame test.

D. LAN Cabling:
   1. Comply with requirements in Section 27 1513 "Communications Copper Horizontal Cabling."

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PATHWAYS

A. Cable Support:
   1. All cable not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system such as j-hooks for the entire run of each cable including, but not limited to, service loops.
   2. The approved cable support system shall be attached directly to the building steel at a serviceable height. In the event that the building steel is not 5-foot above the finished ceiling, provide a dedicated threaded rod extending within 5-foot of the finished ceiling and mount the support hanger to the threaded rod.
   3. All cable installed shall be attached to independent cable support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep cables neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the cables within each type of panel.
   4. Absolutely no cable not installed in conduit will be allowed to be attached directly to the building's steel or supported in any other method than that stated above.
   5. Coordinate with all other trades on the Project to ensure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed cabling.

B. Conduit/Raceway:
   1. All wiring shall be installed in an approved conduit/raceway system (except where permitted by NEC and the local authority having jurisdiction). Maximum conduit "fill" shall not exceed 40 percent per NEC.
   2. Conduit and raceway system shall be installed as specified under Division 26 Section "Raceways and Boxes for Electrical Systems".
   3. Minimum conduit size shall be 3/4-inch EMT. Provide engineered shop drawings for approval prior to installation.
   4. All conduit ends shall have a protective bushing to prevent wire damage. Bushings must be installed prior to installing cable or wire. Cutting the bushing to install around installed cables or wires will not be accepted.

3.03 WIRING AND CABLING INSTALLATION

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Comply with Division 27 Section "Communications Optical Fiber Backbone Cabling" and with Division 27 Section "Communications Copper Horizontal Cabling".

C. All wiring shall be in accordance with the National Electrical Code and Local Codes. All wiring sizes shall conform to recommendations of the equipment manufacturer and as indicated on the engineered shop drawings.

D. All wire shall be UL Listed CL2 for limited energy (300V) applications and shall be installed in conduit. Limited energy MPP wire may be run open in return air ceiling plenums provided such wire is UL Listed for such applications and is of the low smoke producing fluorocarbon type and complies with NEC Article 760 if so approved by the local authority having jurisdiction.

E. No AC wiring or any other wiring shall be run in the same conduit as security alarm wiring.

F. Install LAN cables using techniques, practices, and methods that are consistent with Category 6 rating of components and fiber-optic rating of components, and that ensure Category 6 and fiber-optic performance of completed and linked signal paths, end to end.

G. Systems utilizing open cabling techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where cabling might be exposed or subject to damage.

H. Junction boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with tamper resistant fasteners and/or tamper detection switches. In addition, hinged enclosure doors shall be equipped with locking hardware. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

I. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.04 CABLE APPLICATION

A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 485-A Cabling: Install at a maximum distance of 4000 feet between terminations.

D. Card Readers and Keypads:
   1. Install number of conductor pairs recommended by manufacturer for the functions specified.
   2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
   3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
   4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.

3.05 GROUNDING

A. Comply with Division 26 Section "Grounding and Bonding."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:
   1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   2. Bus: Mount on wall of main equipment room with standoff insulators.
   3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.06 PUSH BUTTON INSTALLATION AND IDENTIFICATION

A. Provide pushbutton(s) at location(s) indicated on drawings to initiate lockdown sequence. Provide clear polycarbonate cover with local alarm horn over pushbutton to avoid accidental activation. Button shall be color-coded and labeled as follows:
   1. “LOCKDOWN” – Red

3.07 IDENTIFICATION

A. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

B. Provide self-adhesive, color-coded, identification marker on ceiling grid directly below any device requiring an IP-connection or service above the ceiling. Ceiling marker to be Seton L12723 or equivalent. Security related devices should utilize a black identification marker on the ceiling grid.

C. At Project completion, cable and asset management documents shall reflect as-built conditions. Provide an electronic PDF overall plan of the school with access control door hardware locations marked in red.

3.08 SYSTEM SOFTWARE AND HARDWARE

A. New system shall integrate with Owner’s existing district-wide credential management and access control solution.

B. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

C. Provide two (2) electronic copies of the final programming and program software to the Owner’s Security Supervisor after final approval.

3.09 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.

2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports. Submit a written test report from an authorized representative of the equipment manufacturer that the system has been 100 percent tested and approved. Final test shall be witnessed by Owner, Engineer, Contractor and performed by the equipment supplier. Final test report must be received and acknowledged by the Owner prior to Substantial Completion.

3.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer’s instructions.

C. Handling: Protect materials from damage during handling and installation.

3.11 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.
1. Complete installation and startup checks according to approved procedures and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.
3. Provide on-site visit by Manufacturer’s in-house personnel to train Owner’s operations personnel.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the ACSMS equipment.

B. Provide a minimum of eight (8) hours of video recorded training for the Owner.

C. Coordinate training and demonstration with Division 28 Section “Access Control Software and Database Management.”

END OF SECTION

SECTION 28 2200
VIDEO SURVEILLANCE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes a video surveillance system consisting of video management systems, IP security cameras, network digital video recorders, data transmission wiring, and accessory equipment.

B. Provide licenses, equipment, storage space, and any other items required to expand the Owner's existing VMS to add all devices shown on the Drawings. The installation shall comply with applicable codes and standards in effect at the Project site and as indicated in the Specifications and Drawings.

C. Coordinate with other system vendors, where appropriate, to facilitate equipment installation, scheduling, protection of equipment and access to the Project site in order to provide the Owner a substantially complete project in a timely manner.

1.02 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

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

N. UPS: Uninterruptible power supply.

O. VMS: Video Management System

P. WAN: Wide area network.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: The proposing/installing contractor shall meet/provide the following requirements:

1. Dealer/integrator of the VMS Manufacturer authorized to sell, install, program, train, and service the proposed manufacturer's system.
2. Licensed by the State of Texas as a security services contractor to design, sell, install, and service security systems.
3. Ability to provide 24-hour, 365 day per year emergency service with factory trained service technicians.
4. Personnel on staff that have been actively engaged in the business of designing, selling, installing, and servicing video surveillance systems for at least ten (10) years.

5. Certified by the manufacturing company in all aspects of design, installation, and testing of the products described herein. Each contractor shall furnish with their submittal a letter from the manufacturer indicating they are a dealer in good standing.
6. Certified by the manufacturer of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturer components and distribution channels.
7. Experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The contractor shall own and maintain tools and equipment necessary for successful installation and testing of video surveillance distribution systems and have personnel who are adequately trained in the use of such tools and equipment.
8. Resume of qualifications shall be submitted with the Contractor's proposal indicating the following:
    a. A list of five (5) recently completed projects using the product proposed of similar type and size with contact names and telephone numbers for each.
    b. A list of test equipment proposed for use in verifying the installed integrity of metallic cable systems on this Project.
    c. A technical resume of experience for the Contractor's project manager and on-site installation supervisor who shall be assigned to this Project.
    d. A list of technical product training attended by the Contractor's personnel that shall install the video surveillance system shall be submitted.
    e. Any subcontractor who shall assist the video surveillance contractor in performance or this work shall have the same training and certification as the video surveillance contractor.
9. Submit to Engineer, prior to the start of any work, the factory training certificates for all personnel that will be working on the Video Management System. No person is allowed to work on the system without proper manufacturer's certification.

B. The entity providing pricing to furnish and install the system specified within this Specification Section and the physical installing entity of this system shall be one in the same. Absolutely no subcontracting on any portion of this system, by the system's proposing entity, will be allowed.

C. Contractor must be a current integrator of solution in the Houston area, have a permanent office located within 150 miles of the Project, and be able to include information on current support staff to be able to service the client.

D. The Owner's representative reserves the right to reject any and all portions of the work performed, either on technical or aesthetic grounds.

1.04 REGULATORY REQUIREMENTS

A. Standards: All work shall be performed in accordance with the latest revisions of the following standards and codes:
1. Local Building Code
2. Local Electrical Code
3. NEC National Electrical Code

B. Other References:
1. TIA/EIA-568-A – Commercial Building Telecommunications Wiring Standard
2. TIA/EIA-569 – Commercial Building Standard for Telecommunications Pathways and Spaces
3. TIA/EIA-606 – The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. TIA/EIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications

5. TIA/EIA TSB 67 – Transmission Performance Specification for Field Testing of Unshielded Twisted-Pair Cabling Systems
6. ISO/IEC 11801 – Generic Cabling Standard
7. EN 50173 – Generic Cabling Standards for Customer Premises

C. Governing Codes and Conflicts: If the requirements of these Specifications or Drawings exceed those of the governing codes, regulations, and manufacturer's installation requirements, then the requirements of these Specifications and Drawings shall govern. However, nothing in the Drawings or Specifications shall be construed to permit work not conforming to all governing codes, regulations, and manufacturer's installation requirements.

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals" for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals".

C. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes. Complete manufacturer's product literature for all cable, termination components, cable supports, cable labels, field devices, and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the Owner/Engineer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included. The submittal shall have some type of distinguishing marker or pointer to indicated specific product that is to be provided.

D. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
1. Location of all control equipment and remote power sources
2. Location of all field devices and outlets
3. Location of wall penetration sleeves including size of each sleeve and quantity of cables passing through each sleeve
4. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
5. Wiring Diagrams: For power, signal, and control wiring.

E. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product Warranty: Sample of special warranty.

C. Testing: Proposed system test result forms and a list of instrumentation to be used for systems testing.

D. Certifications: The contractor shall submit all of the following certifications and the certifications must contain dates which are valid from the date of proposal and not expire any sooner than 12 months after Substantial Completion of the Project.

1. Manufacturer's Authorized Dealer/Installer Certification: This certification must be held by the proposing/installing contractor and state that the proposing/installing contractor is an authorized dealer/installer of the system specified within the Project Specifications. The certification must have been obtained by the office that is within a 75-mile radius of the Project's location.
2. Installer Certification: This certification must be held by at least 25 percent of the on-site staff and be made available at the site if requested by the Owner, Architect, and/or Project's Technology Consultant.
3. Licenses: This includes all licenses required by the State of Texas, the federal government, local authorities having jurisdiction, and any organization that governs the specific system.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," and in Division 28 Section "Electronic Safety and Security Shop Drawings and Submittals," include the following:
   1. The manual shall also include manufacturer's data sheets and installation manuals/instructions for all equipment installed and a list of recommended spare parts.
   2. Replacement components recommended to be stored at the site for ready access.
   3. Generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
   4. Operating and maintenance instructions for all devices within the system. These instructions shall reflect any changes made during the course of construction and shall be provided to the Owner for their use in a three-ring binder labeled with the Project name and description.
   5. Provide a copy of the sign in and training sign off sheets.

B. Inspection and Test Reports: During the course of the Project, the Contractor shall maintain an adequate inspection system to ensure that the materials supplied and the work performed, conform to contract requirements. The Contractor shall provide written documentation that indicates that materials acceptance testing was conducted as specified. The Contractor shall also provide documentation which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion.
   1. Provide complete test reports for all cabling and devices that comprise system as outlined in this document.
   2. Include the name, address and telephone of the authorized factory representative with a 24-hour emergency service number.

C. As-Built Drawings: An up-to-date record set of approved shop drawing prints that have been revised to show each and every change made to the structured cabling system from the original approved shop drawings. Drawings shall consist of a scaled plan of each building showing the placement of each individual item or the technical cabling system equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway.
   1. Include cable pathways, device locations with correct labeling, control equipment locations, remote power supply locations, cross connect locations, and MDF/IDF locations. The as-built drawings shall be prepared using AutoCAD 2017 or later. Provide the Owner with electronic versions of the as-builts on CD media and one (1) hard copy set per binder.

2. All Drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or the end user unless device addressing is electronically generated, and automatically graphically self-documented by the system.
3. One (1) 30” x 42” laminated floor plan sheet of each floor/area illustrating technology drops and cable designation. Contractor shall provide one complete floor plan sheet for each system panel and remote power supply location.

D. Warranty: A copy of the manufacturer’s warranty on the installed system.

E. Any keys to cabinets and/or equipment and special maintenance tools required to repair, maintain, or service the system.

1.08 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
2. Interior, Uncontrolled Environment: System components installed in non- temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. Use NEMA 250, Type 3R enclosures.
4. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.09 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5-year experience manufacturing similar products.

B. System Integrator shall provide the following as part of the System Solution:
1. Complete product and technical data specification sheets that include all material and equipment and shall be available freely online.
2. List of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
3. List of all equipment with part numbers, manufacturer, firmware, and assigned IP addresses.
4. Placement Diagram showing the proposed location of all system hardware devices.
5. System Calculation of all network bandwidth and storage requirements for System Servers to ensure proper planning of computing and networking infrastructure.

C. Installer Qualifications: Minimum 2-year experience installing similar products. Installers shall be trained and authorized by the Manufacturer to install, integrate, test, and commission the system.

1.10 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work in this section.
1. End user provides specific details, A/E by specification shall ensure coordination by Contractors to establish and schedule meetings for pre-installation.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Handling: Handle materials to avoid damage.

1.12 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Three (3) years from date of Substantial Completion.

B. All such warranties shall include all parts (All VMS and IP security devices).

C. Labor and all other costs as necessary to maintain the equipment in operating condition as intended by the product manufacturer after a period of one (1) year shall be negotiated with the Owner upon Project completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all incidental and/or miscellaneous hardware not explicitly specified below as required for a complete and operational system.

B. Materials shall be listed or shall be approved equivalent products of other manufacturers meeting the intent and quality level of the Specifications. All approved equivalent products shall be published by addendum ten (10) days prior to proposal for Architect/Engineer review.

C. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer’s system.

D. All systems and components shall have been thoroughly tested and proven in actual use.

E. All systems and components shall be provided with the availability of a toll-free 24-hour technical support phone number from the manufacturer. The phone number shall allow for immediate technical assistance for either the dealer/installer or the end user at no charge.

F. All systems and components shall be provided with an explicit manufacturer warranty.

2.02 MANUFACTURERS

A. Acceptable Camera Manufacturer: Hanwha Techwin, which is located at: 500 Frank W. Burr Blvd.; Teaneck, NJ 07666; 877-213-1222; www.HanwhaSecurity.com.

2.03 IP SECURITY CAMERAS

A. Camera Model Selection Guidelines:
   1. Brand Selection - All cameras provided to Tomball ISD shall be Hanwha Techwin Wisenet cameras. If a dealer chooses to install another brand of camera at any Tomball ISD facility, the camera(s) shall be replaced, at no cost to the Tomball ISD, by the installing dealer with the following approved Hanwha Techwin Wisenet cameras models.
      a. Substitution Request – Dealer may request to submit alternate Hanwha cameras models to Tomball ISD for review and acceptance (or not) by Security Management. If so, specific model acceptance must be approved by Tomball Security Management prior submitting any quotes.
   2. Indoor Camera Guidance (presumes wide angle lens FoV & 40PPF)
      a. Single Sensor Cameras:

1) QNV-8080R – 5MP for viewing areas up to 35-feet away, larger rooms.
2) XNV-6011W – 2MP for viewing smaller areas; viewing area up to 15-feet
3) XND-C6083RV – 2MP viewing entrance/exit doors; viewing area up to 20-feet
4) XND-C8083RV – 6MP viewing lobbies, waiting areas, larger rooms; viewing area up to 40-feet
5) XND-C9083RV – 4K large lobbies, long hallways, large rooms, warehouses, or situations requiring highest resolution details; viewing area up to 55-feet
6) PND-A9081RV – 4K AI camera for high level awareness of object (person/vehicle) detection and alerting

b. 360-degree Fisheye Cameras:
1) XNF-9010RV – 12MP 360-degree view for larger rooms (30’ x 30’) or areas requiring greater resolution detail such as cash handling, people identification, etc.

c. Multi-Sensor Cameras:
1) PNM-9000VD – Dual 2x 5MP camera for hallways (2 views); viewing area up to 40-feet each camera direction.
2) PNM-8082VT – Triple 3x 2MP camera for T-hallways (3 views); viewing area up to 20-feet each camera direction.
3) PNM-9084QZ – Quad 4x 2MP camera for 4 hallways (4 views); viewing area up to 20-feet each camera direction.
4) PNM-9085RQZ – Quad 4x 5MP camera for 4 hallways (4 views) / rooms; viewing area up to 40-feet each camera direction.

3. Outdoor Camera Guidance (presumes wide angle lens FoV & 40PPF):
a. Single Sensor Camera
1) XNV-C6083R – 2MP camera viewing entrance/exit doors; viewing area up to 20-feet.
2) XNV-68083R – 6MP camera area view; viewing area up to 40-feet.
3) XNV-C9083R – 4K camera larger area views; viewing areas up to 55-feet
4) PNV-A9081R – 4K camera AI high level alerts / notifications

b. Panoramic Cameras – 180-degree view
1) PNM-9022V – 4x2MP panoramic 180-degree view camera; viewing distances up to 30-foot radius.
2) PNM-9031RV – 4x5MP panoramic 192-degree view camera; viewing distances up to 50-foot radius.
3) PNM-9085RQZ – Quad 4x 5MP parking lot camera, 360-degree viewing.

c. 360-degree Fisheye Cameras
1) XNF-9010RV – 12MP 360-degree view

d. Multi-Sensor Cameras:
1) PNM-9000VD – Dual 2x 5MP camera for hallways (2 views); viewing area up to 40-feet each camera direction.
2) PNM-8082VT – Triple 3x 2MP camera for T-hallways (3 views); viewing area up to 20-feet each camera direction.
3) PNM-9084QZ – Quad 4x 2MP camera for 4 hallways (4 views); viewing area up to 20-feet each camera direction.
4) PNM-9085RQZ – Quad 4x 5MP camera for 4 hallways (4 views) / rooms; viewing area up to 40-feet each camera direction.

4. Elevator Camera:
a. XNV-6012 – Small form factor surface mount in elevator; include optional Power over Ethernet (PoE) as needed:
1) Hanwha Model TEU-F01 for powering (POE) camera over Unshielded Twisted Pair (UTP / CAT wire) elevator cab traveler wire

2) Hanwha Model TEC-C01 for powering (POE) camera over Coax elevator cab traveler wire (use with legacy (existing) Coax camera upgrades).

B. Minimum Camera Performance Requirements:
1. Video Compression and Transmission: Cameras shall have the following properties relating to video signals they produce.
a. Compression: H.265, H.264 and MJPEG. Each derived from a dedicated encoder and capable of being streamed independently and simultaneously.
1) H.265 and H.264: Maximum of 30 fps at all resolutions.
2) MJPEG: Maximum of 30 fps
b. Video Stream Profiles: Able to configure 6-10 independent profiles with differing encoding, quality, frame rate, resolution, and bit rate settings.
c. Video Streams: 10 independent stream types using unicast protocol.
1) Multicast and unicast video streaming.
d. DDNS Configurable: At no additional cost by manufacturer.
e. Smart Codec: Dynamic GOV, and Dynamic FPS to efficiently manage bitrate of video stream.
2. Camera Physical and Performance Properties:
a. Impact Protection: IK08~IK10 vandal resistance for indoor cameras
b. IP66 rating minimum for Outdoor Cameras
c. Resolution and FPS
1) 2MP camera imager sensors shall transmit full 1080P resolution (1920x1080) at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
2) 5MP camera imager sensors shall transmit full 2560x1920 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
3) 6MP camera imager sensors shall transmit full 3328x1872 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
4) 4K camera imager sensors shall transmit full 3840x2160 resolution at a 30FPS using all Codecs (H.265/H.264/MJPEG) with no FPS reduction with the implementation of WDR and / or analytics in the camera.
d. Configurable privacy masking regions utilizing a 4 point polygon
e. Camera Models with IR Illumination True day and night operation with removable IR cut filter.
f. Digital Noise Reduction: 2D and 3D technology.
g. Cameras for viewing in darkness shall include Integral IR illumination, providing effective visibility of 65.62 ft (20 m) at 0 Lux when activated in black and White mode.
3. Intelligence and Analytics: A suite of integral intelligent operations and analytic functions to include:
a. Motion Detection: Eight definable detection areas with 8 point polygonal zones, minimum and maximum object size.
b. Logical Events Detection from Camera Video Input:
1) Tampering (scene change).
2) Defocus detection.
3) Motion detection with metadata.
4) Virtual Area Based Event:
(a) Enter or exit.
5) Virtual Line Based Event:
(a) Directional detection.
(b) Crossing.

4. Interoperability: ONVIF Profile S, G, and T compliant and SUNAPI API.
5. Camera Characteristics:
    a. Built-in web server, accessed via standard browsers including MS Internet Explorer, Firefox, Chrome and Safari.
    b. Dual edge recording slot like Micro SD/SDHC/SDXC memory card with configurable pre-alarm and post-alarm recording intervals.
    c. Bi-directional audio.
    d. Alarms and notifications supported.
    e. PoE capable.
6. Multi-Sensor Camera Additional Requirements:
    a. In addition, all multi-sensor cameras (including Duo (2) Imager Sensors and Quad (4) Imager Sensors) shall also include the following Model: PNM-7002VD/PNM-9000VD, PNM-9084QZ, PNM-9084RQZ, PNM-9085RQZ, PNM-9002VQ, PNM-9022V and PNM-9030V, PNM-9031RV, PNM-9322VQP as manufactured by Hanwha Techwin America.
    b. Each Video Channel shall utilize a dedicated SOC to that Video Channel to process and deliver full frame rate video at 30 FPS using all Compression Codecs (H.265, H.264 and MJPEG), with no degradation or reduction to any individual Video Channel or Collectives Channels when enabling WDR or advanced video analytics.
    c. Each Video Channel shall support individual enablement of intelligent analytics, WDR, and codec selection independent of the remaining video channels.
    d. Each Channel supports SD card.
    e. One single power supply for all multi-channels

C. UPS and Electrical Surge Protection:
1. All Network Camera to NVR Connections Shall incorporate an appropriate in line network Surge Protection Device when the Network Camera is located on the exterior of a building and connecting network switch / Network Recorder on interior of building.
2. All Critical Operation Network Cameras shall be on a POE Switch attached to a Pure Sine Wave Power Conditioning UPS or UPS circuit that is sized for the specified required operational time. It is recommended that all UPS systems are sized to provide back-up power for a minimum of 20 minutes or owner stated guidance, with 20% growth capacity, to maintain Video System Operation during brief outages or generator activation and power cut over.

2.04 VIDEO MANAGEMENT SYSTEMS (VMS)

A. Video Management System (VMS):
1. Software: Wisenet Wave v4.2 as manufactured by Hanwha Techwin America.
2. System Requirements:
    a. Open video platform designed for use in any video application.
    b. Specified Software: To include, free of charge, any API or SDKs necessary to integrate third party devices and systems.
    c. Specified Video Management Solution's Architecture: To include Desktop, Media Server, Mobile, and Cloud applications.
3. Software Components Characteristics: Four applications working seamlessly together.
    a. Cloud Application: Enables simple remote connectivity, viewing, and management of an unlimited number of systems and users.
    b. Media Server Application: Responsible for discovering, connecting to, and managing system users, devices, and associated data.
    c. Desktop Application: Capable of acting as a stand-alone media player or as a client application for connecting to and managing systems.
    d. Mobile Application: For iOS and Android devices that allows users to connect to, view, search, and control IP cameras over Wi-Fi or Data networks.

4. Built-In Developer and Integration Tools: Accessible from System Server's Web Admin Interface (compatible with all major browsers).
    a. Server API: SUNAPI implementation giving developers the ability to access every system feature available.
    b. API Change Log: List of breaking changes in API from version to version.
    c. Video Source Integration SDK: Integrate virtually any live or recorded video source (IP Cameras, NVRs, DVRs, etc.) into the VMS with methods for discovering, displaying, analyzing and recording video, as well as integrating device I/O ports and related motion detection information.
5. System Architecture:
    a. Server Hive Architecture:
        1) System servers are equal synchronizing system databases in real-time.
        2) Users can connect to any system server to see and manage entire system.
        3) Servers support automatic camera failover ensuring limited loss of video recording in event of hardware or network failure.
    b. One-Click System Wide Updates:
        1) System Administrators' Capabilities:
            (a) Upgrade entire system via single button in Desktop Application.
            (b) Upgrade on demand to latest release or specific builds with specific functionality or bug fixes.
    c. Use secure technologies for inter-application communication and security.
        1) Email Server: Client (Mobile, Desktop, Web) Communications - HTTPS Email - TLS / SSL - TLS; default option.
        2) Salted/Hashed Passwords: Local credentials protected using a salted MD5 hash, cloud credentials should use a complex multi-level hash.
    d. The VMS will not require any licenses to increase the number of supported devices, users, or servers.

B. VMS Server Application:
1. Runs on the following operating system:
    a. Microsoft:
        1) Windows 10 Professional, Windows 10 IOT Enterprise.
        2) Windows Server 2019.
2. Minimum Compatible Computing Hardware:
    a. Any hardware able to run a compatible operating system.
    b. Capable of recording 128 dual-streaming IP cameras (256 streams) on a single core of an Intel Core i5 processor.
3. Performance:
    a. Automatically discover, stream, and record any ONVIF Profile S IP camera located on same subnet as server application.
    b. Manually discover, stream, and record RTSP, HTTP, or UDP (multicast, unicast) streams.
    c. Automatic camera failover without any additional licenses.
    d. Unlimited number of users and custom user roles.
    e. User Login Credential Management: LDAP / Active Directory / Open LDAP integration.
    f. Record and Stream
        1) Video: H.264, H.265, and MJPEG.
        2) Audio: AAC, PCM (mu-Law, A-law), g726, and MP3.
    g. Transcode Streams on Demand: For delivery to 3rd party system devices.
        1) Codecs: H.265, H.264, MJPEG or WebM.
    h. Pass-through high-res or low-res HLS streams from connected devices.

i. Support Addressing: IPv4 or IPv6.
j. Operator ability to change size of reserved disk space for storage drives.
k. Concurrent recording of all connected cameras / streams to two servers in real-time.
l. Server-side, CPU-based motion analysis for all connected IP cameras with no perceptible increase, less than 3 percent, in CPU usage.

C. VMS Desktop Application:
1. Runs on the following operating systems:
a. Microsoft:
1) Windows 10
2) Windows 10 IOT Enterprise Solutions.
3) Windows Server 2019
b. Apple / Mac:
1) OSX 10.12: Sierra.
2) OSX 10.13: High Sierra.
3) OSX 10.14: Mojave.
2. Minimum Compatible Computing Hardware:
a. Any hardware able to run a compatible operating system with a CPU that supports OpenGL 2.1 and Intel HD Graphics 3000 (or higher).
b. Will not require any dedicated graphics drive to work at full capacity; 64 streams on a 64 bit OS, 24 streams on a 32 bit OS, and use the CPU for all video decoding and rendering.
3. Performance and Basis Structure:
a. Navigation Panel: Main menu button, an interactive cloud-login icon, tabbed layouts, minimize and maximize icons, a contextual help icon, and a close application icon.
b. Resource Panel (Left): Contains all system resources (Servers, Devices, Users, Layouts, Offline files, etc.) with collapsible structure and a keyword search mechanism to allow operators to quickly search for a display live streams / cameras, offline video and image files, or any combination thereof.
c. Notifications Panel (Right): Shows all system or rules-engine generated notifications which can be clicked on to display relevant resource in the viewing grid.
d. Timeline Panel (Bottom): Allows for navigation and search of recorded video files.
e. Viewing Grid (Main Viewing Area): A flexible adaptive grid interface which allows operators to create and share customized layouts of system resources.
4. Operation: Allow operators to do the following:
a. Scroll to and zoom in on any zone of viewing grid.
b. Drag and drop to reassign cameras from one server to another server.
c. Via a flexible timeline, view dates of any and all archived video in the System for a specific camera, or groups of cameras.
d. Manually Create Bookmarks: With start time, end time, name, description, and tags, for later search. Bookmarks must also be able to be created using the Rules engine.
e. Execute a Smart Motion Search: By selecting a subset of a live camera stream with results shown in red on the flexible timeline. Smart Motion search should be able to search a year (12 months, 365 days) of archived video in less than one second.
f. Search video archives by date and time with a responsive, adaptive timeline.
g. View, search and export all system events, system bookmarks, system logs and audit trail of operator actions and replay related video.
h. Create and share lockable layouts.
i. Modify and save a shared layout to affect an instantaneous change to that layout on the VMS Desktop application of any user connected to the system viewing that layout (when the system administrator saves the layout the layout will update in real time for any user viewing that layout).

j. Support two-way audio between operators and supported devices.
k. Support audio alerts as an action that can be played on users' computers or connected system devices.
l. Force open an alarm layout triggered by any system or 3rd party event with one or many associated cameras or resources.
m. Force users to set the camera's initial password upon enrollment for best cyber security practices.

2.05 VMS SOFTWARE LICENSES

A. All new systems shall provide, at minimum, one WAVE VMS license per camera. Additionally, if additional cameras are being added to existing system, dealer shall include one new WAVE license per camera. Following are the acceptable WAVE VMS camera license references.

B. Model: WAVE-PRO-01,-04,-08,-16,-24,-48 as manufactured by Hanwha Techwin America
1. Description: WAVE camera license, Enables one IP stream recording per “-0x” license(s) purchased.
a. Purchase sufficient quantity of WAVE licenses as needed to record the number of camera streams being added to a WAVE System
b. Note: Cameras that used only for Live Patient Room Monitoring and will NOT be recorded, then WAVE licenses for these specific cameras are not necessary. However, proper sizing of the Recording Server is still required to support the cameras.

C. Model: WAVE-VW-02 as manufactured by Hanwha Techwin America
1. Description: WAVE, Video Wall License, Enables displaying video on up to two (2) additional monitors with remote control of video displayed on those monitors.

D. Model: WAVE-ENC-04 as manufactured by Hanwha Techwin America
1. Description: WAVE, 4 Channel Encoder License

E. Model: WAVE-IO-01 as manufactured by Hanwha Techwin America
1. Description: WAVE, I/O module license, Enables one (1) I/O module.

2.06 CLIENT WAVE WORKSTATION

A. Model: WWT-P-7401 WAVE Client Workstation supporting up to Four (4) attached monitors.
1. The Workstation shall have a dedicated operating system drive to facilitate accelerated boot and application load times.
a. OS Drive – 1x 256GBSSD internally mounted with Operating System - Microsoft Windows 10 Pro
2. Video Storage - support to add additional 3.5” drive with capacity options for 1TB, 2TB, 4TB, 8TB, 10TB, 12TB, or 14TB per drive at Speed of 7200 rpm
3. Processor: Qty 1 Intel® 9th Generation Core™ Processor, Intel® Core™ i7-9700, 3.0Ghz to 4.7Ghz (8 Cores, 8 Threads, 12MB) and 16 GB DDR4 RAM memory
4. Graphics Cards - NVIDIA® Quadro® P620 with 4x HDMI adapters
5. Network Controller 1. Ports: 1 x 1GbE RJ45
6. Additional Ports - Video output: Varies with GPU, (1) HDMI 2.0b, (1) DisplayPort 1.4 on motherboard, up to (4) DisplayPort 1.4 , USB: Front: (2) USB 3.1, (2) USB 2.0, Rear: (2) USB 3, (2) USB 2.0
7. Electrical - Power: 100–240 V AC, auto-ranging, Power Supplies: 200W 80 Plus Bronze
8. Mechanical - Dimensions (w x d x h): 3.7" (97mm) x 11.5" (292mm) x 11.4" (290mm)
9. Weight: 11.42 pounds (5.14 kg)
10. Environmental - Operating temperature: 50°F - 95° F (10°C - 35°C)

B. UPS and Electrical Surge Protection:

1. All Client Workstations shall be connected to a properly sized Pure Sine Wave Power Conditioning UPS or circuit to prevent voltage fluctuations (increase or decrease) that can affect operation and cause damage to the equipment.
2. All Client Workstations shall be installed on an electrical circuit that incudes protection against transient voltage surges.
3. It is recommended that all UPS systems are sized to provide back-up power for a minimum of 20 minutes or owner stated guidance, with 20% growth capacity, to maintain Video System Operation during brief outages or generator activation and power cut over.

2.07 ACCESSORIES

A. Accessory Products: Provide the following accessories to properly install and mount all cameras as required by the specific camera installation locations, as applicable to the system selected and as scheduled on the Drawings.
   1. Pendant caps
   2. Corner mount brackets
   3. Wall mount brackets
   4. Recess mount kits
   5. Pole mount brackets
   6. Back box mounts
   7. 2x2 ceiling mounts
   8. Sun shields
   9. Work boxes
   10. Smoked dome covers
   11. PTZ/Dome housings
   12. PTZ/Dome mounts
   13. HD CCTV accessories
   14. Network camera PoE injectors and accessories
   15. UTP video devices
   16. Monitor stands
   17. Surge protection
   18. UPS battery back-up
   19. UPS circuits

2.08 CABLE AND INSTALLATION

A. All required network cabling to each camera location on this Project shall be provided by the Owner’s structured cabling system installer, unless otherwise noted. All camera IP data cabling shall be yellow in color.

B. Provide all penetrations and all conduits as necessary for installation of security camera installation.

C. All exterior penetrations require necessary weatherproofing to avoid moisture penetration.

D. All outdoor cable runs underground shall be rated for underground use.

E. Provide all power circuits required for the servers and camera power supplies.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. System Integrator: Confirm the solution proposal planning and design with the installing contractor (if different company from integrator), to be in compliance with Ochsner standards as described in this document, with any exception approved in writing by Ochsner Security Administration.

B. The network design and configuration to be verified for compatibility and performance with the input/output devices.

C. Network Configuration: Tested and qualified by Systems Integrator prior to remote device installation.

D. Equipment to be tested and configured in accordance with instructions provided by the System Integrator prior to installation.

E. All firmware found in products to be the latest and most up-to-date provided by the manufacturer, or of a version as specified by the provider of the Video Management Application (VMA).

F. All equipment requiring users to log on using a password shall be configured with user/site-specific password/passwords. No system/product default passwords shall be allowed.

G. Confirm hardware will be stored in an environment where temperature and humidity are in the range specified by the Manufacturer.

3.03 INSTALLATION

A. Install products per manufacturer's recommendations and approved submittals.
   1. Comply with manufacturer's installation and configuration documentation available to the System Integrator to ensure all steps have been taken to provide a reliable, easy-to-operate system.
      a. System Integrator shall be a Hanwha Techwin (Silver or higher) STEP Partner in good standing with manufacturer.
      b. System Integrator shall provide Technicians that have completed, at minimum, Hanwha WAVE Online Technician Training program.
      c. STEP Partner shall be able to offer extended warranty were applicable.
   2. Program and configure all products per the requirements of Tomball ISD Standards and specific site requirements which shall include, at minimum, the following: (additional requirements may applicable, refer to Tomball ISD Security Administration for details).
      a. All cameras and Network Recorders shall be programmed with Tomball ISD provided IP addresses and password requirements, along with naming guidance as instructed by Tomball ISD Security Administration.
      b. All Network Camera Recorders shall use the Tomball ISD NTP (Network Time Protocol) designated server.
      c. All IP Cameras shall have the primary Video Stream programmed to send 15 FPS at 2MP, 5MP, 6MP, 4K (depending on camera model), using the H.265 Codec to stream to the Network Recorder for recording.
      d. All IP Cameras shall have the secondary Video Stream programmed to send 7FPS using H.265 codec to the Network Recorder for client display and non-motion detection recording if motion based alarm recording is implemented.
      e. All IP Cameras shall have a third Video Stream programmed to send 7 FPS at VGA (640x480) using H.264 to the Network Video Recorder for remote access via mobile device as needed.
      f. All indoor cameras shall have video motion detection zones configured and active and walk tested for sensitivity functionality for use during facility closed hours (if applicable to the facility).

g. All outdoor cameras, if using motion detection, shall have objects such as trees or bushes that can move from the wind, to have motion detection masked off. Outdoor motion detection shall be used carefully for viewing areas considered stable (not plants) such as sidewalks, roads, buildings, doors, and the cameras shall have adequate artificial lighting provided or utilize camera IR light.
h. All VMS Client Workstations shall be configured to automatically connect to the designated Network Recorders upon launch of the VMS Client application.
i. Training – User Training may be required and is to be included as needed. Contact Tomball ISD Security Administration for guidance.

B. System Integrator personnel must comply with all applicable state and local licensing requirements.

C. Prior to acceptance of installed system, the System Integrator will test the system in conditions simulating the final installed environment, which shall be witnessed by the Owner or Owner's Representative, and shall adjust the complete system as required until proper operation is achieved.
1. System Integrator shall email a copy of the final approved Wisenet Device Manager Site Configuration File and Wisenet Device Manager Report as part of the job completion process.

3.04 WIRING

A. Comply with requirements in Division 27 Section "Pathways for Communications Systems."

B. Wiring Method:
1. Install cables in raceways, except in accessible indoor ceiling spaces. Conceal raceways and wiring except in unfinished spaces.
2. In suspended ceiling areas where duct, cable trays, or conduit are not available, Contractor shall bundle, in bundles of 15 cables or less, with cable ties snug, but not deforming the cable geometry. Cable bundles shall be supported with J-hooks attached to the building structure and framework at a maximum of 5-foot intervals. Plenum rated cables ties shall be used in all appropriate areas. The Contractor shall adhere to the manufacturer's requirements for bending radius and pulling tension of all cables.
3. Cables shall not be attached to accessible ceiling grid supports or laid directly on the ceiling grid.
4. Cables shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.

C. Cable Support:
1. All cable not installed inside conduit or a designated cable tray system shall be installed in a dedicated cable support system for the entire run of each cable including, but not limited to, service loops.
2. The approved cable support system shall be attached directly to the building steel at a serviceable height. In the event that the building steel is greater than 5-feet above the finished ceiling, provide a dedicated threaded rod extending 5-feet above the finished ceiling and mount the support hook to the threaded rod.
3. Cable support shall be installed at a maximum of 5-foot on center.
4. All cable installed shall be attached to the support system with plenum rated Velcro and a plenum rated Velcro tie shall be installed between each cable support to keep wires neatly bundled throughout the entire run. Tie wraps will only be allowed to be used inside the control panels as required to manage the wires within each type of panel.
5. Absolutely no cable, not installed in conduit, will be allowed to be attached directly to the building steel or supported in any other manner than as stated above.

6. It is the responsibility of the installing contractor to coordinate with all other trades on the Project to ensure that the pathway of this system does not interfere with the installation of the other trades and to prevent the installed product of other trades from putting strain on the installed wiring.
7. Do not route cable through webbing or structural steel.

D. Conduit/Raceway:
1. Conduit and raceway system shall be installed as specified under Division 26 Section “Raceways and Boxes for Electrical Systems.”
2. Minimum conduit size shall be ¾-inch EMT. Maximum conduit “fill” shall not exceed 40 percent per NEC.
3. Systems utilizing open wiring techniques with low smoke plenum cable shall provide conduit in all inaccessible locations, inside concealed walls, all mechanical/electrical rooms, or other areas where wiring might be exposed or subject to damage.
4. All conduit ends shall have a protective bushing to prevent cable damage. Bushings must be installed prior to installing cable. Cutting bushing to install around installed cables will not be accepted.

E. Fire Wall Penetrations: The Contractor shall avoid penetration of fire rated walls and floors wherever possible. Contractor shall also seal all floor, ceiling and wall penetrations in fire or smoke barriers and in the wiring closet.

F. Wall Penetrations: Where penetrations are necessary, they shall be sleeved with metallic conduit and resealed with an Underwriter Laboratories (UL) approved sealant. Provide three-sided pre-finished metal hood and seal to wall where conduit penetrates exterior wall.

G. Do not install wall mounted cameras into metal fascia. Ensure they are mounted into brick, and sealed top and sides (not bottom).

3.05 CABLING INSTALLATION

A. Cabling between wiring closet and camera locations shall be made as individual home runs. No intermediate splices may be installed or utilized between the wiring closet and the camera location.

B. All cable must be handled with care during installation so as not to change performance specifications.

C. Placement: All cabling and associated hardware shall be placed so as to make efficient use of available space. All cabling and associated hardware shall be placed so as not to impair the Owner’s efficient use of their full capacity.

D. Cabling 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.

E. For communication wiring, comply with the following:
1. Division 27 Section "Communications Optical Fiber Backbone Cabling."
2. Division 27 Section "Communications Copper Horizontal Cabling."

F. Pulling Cable: Do not exceed manufacturer's recommended pulling tensions. 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.

G. Do not run any power cabling for any security equipment on rack tray system due to EMI considerations. Provide individual cabling support for all low voltage power cabling.

3.06 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 27 Section "Common Communications Requirements."

B. Labels: The Contractor shall label all outlets using permanent machine engraved labels approved by the Owner. Label patch panels in the MDF or IDF to match those on corresponding camera locations. The font shall be at least one-eighth inch (1/8”) in height, block. All labels shall correspond to as-builts and to final test reports.

C. Contractor shall ensure complete typed labeling of all cameras with numbers that correspond to locations on video server. Labeling system shall correspond to the Owner’s labeling system. Verify with Owner. Provide tags (black letters on white labels, plastic coated) on all cables and outlets.

D. All cables shall be labeled at both ends with a machine label and all terminations shall be stenciled with a typed label for quick circuit identification. Labeling shall conform to TIA/EIA standard 606 and include interconnect cable identification numbers.

E. A floor plan, clearly labeled with all numbered camera locations, shall be included in the as-built plans.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Informational Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult Owner's personnel.
      f. Set sensitivity of motion detection.
      g. Connect and verify responses to alarms.
      h. Verify operation of control-station equipment.
   3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.08 SYSTEM STARTUP

A. Work shall be complete and ready to operate prior to final acceptance.

B. Program initial user groups and users.

C. Video Surveillance System shall be preprogrammed to include a floor plan graphic of each area where cameras are located and the exact camera locations and name of cameras. Field verification of camera names is required to complete this task.

D. Video Surveillance System shall be programmed to include Owner’s logical camera groupings.

3.09 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, 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. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

3.10 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.11 DEMONSTRATION AND TRAINING

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.
   1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
   2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.
   3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
   4. Schedule training with Owner, through Architect, with at least seven days advance notice.
   5. Conduct a minimum of six hours training as specified in instructions to Owner's employees in Division 1 Section "Contract Closeout."
   6. Provide a copy of the sign-in and training sign-off sheets in the Operations and Maintenance Manual.

END OF SECTION

SECTION 28 3100
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Integrated Digital Alarm Communicator System (DACS), including but not limited to the following:
      a. Control panel.
      b. Enclosures.
      c. Keypads.
      d. Door Switches.
      e. Motion Detectors.
      f. Accessories required to provide a complete DACS.
      g. Wiring.
   2. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
   3. Integration of other electronic and electrical systems and equipment.
   4. The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the Owner in obtaining the relevant alarm permits.

B. Related Sections:
   1. Division 23 Section “Instrumentation and Control for HVAC”.
   2. Division 28 Section “Access Control Software and Database Management”.

1.03 DEFINITIONS

A. BAS: Building automation system.

B. CCTV: Closed-circuit television.

C. PIR: Passive infrared.

D. RFI: Radio-frequency interference.

E. UPS: Uninterruptible power supply.

F. Control Unit: System component that monitors inputs and controls outputs through various circuits.

G. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

H. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

I. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

J. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.

K. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

L. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

M. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.04 REFERENCES

A. National Fire Protection Association (NFPA)
   1. National Electric Code, Article 760 (NFPA 70).
   2. National Fire Alarm Code (NFPA 72).

B. Administrative Council for Terminal Attachments (ACTA):
   1. ANSI/TIA-968-A-2002 Technical Requirements for Connection of Terminal Equipment to the Telephone Network.

C. American National Standards Institute (ANSI):
   1. ANSI C63.4 Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

D. Federal Communications Commission (FCC):
   1. Title 47 C.F.R. Part 15; Class B – Radiated and Conducted Emissions.
   2. Title 47 C.F.R. Part 68; rules governing the connection of Terminal Equipment (TE) to the Public Switched Telephone Network (PSTN).

E. The National Institute of Standards and Technology of the United States of America (NIST):
   1. Federal Information Processing Standards Publications 197 (FIPS 197) –Advanced Encryption Standard (AES).

F. International Organization For Standardization (ISO):
   1. 9001 - Quality System.

G. Underwriters Laboratories, Inc. (UL):
   1. UL 50 - Enclosures for Electrical Equipment.
   2. UL 294 – Access Control System Units.
   3. UL 365 - Police Station Connected Burglar Alarm Units and Systems.
   4. UL 609 - Local Burglar Alarm Units and Systems.
   5. UL 1076 – Proprietary Burglar Alarm Units and Systems
   6. UL 1610 - Central Station Burglar-Alarm Units.
   7. UL 60950-1 - Information Technology Equipment - Safety.
   8. UL 636 – Hold up alarms

1.05 ACTION SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 01 and Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals” for products specified under PART 2 - PRODUCTS.

B. Specification Compliance Certification: Submit a Specification Compliance Certification in accordance with Division 28 Section “Electronic Safety and Security Shop Drawings and Submittals”.

C. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: Shop drawings shall provide details of proposed system and the work to be provided. Include point-to-point drawings of systems and wiring diagrams of individual devices.
   1. Detailed wiring diagrams and system description.
   2. System device locations on architectural floor plans.
   3. Full Schematic of system, including wiring information for all devices.
   4. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers and control interface devices and media to be used. Describe characteristics of network and other data communication lines.
      a. Indicate methods used to achieve systems integration.
      b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
      c. Describe characteristics of network and other data communication lines.
      d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.
   5. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
   6. UPS: Sizing calculations.
   7. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
   8. Master Control-Unit Console Layout: Show required artwork and device identification.
   9. Retain first subparagraph below for addressable systems.
   10. Device Address List: Coordinate with final system programming.
   11. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
   12. Details of surge-protection devices and their installation.
   13. Sensor detection patterns and adjustment ranges.

E. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

1.06 INFORMATION SUBMITTALS

A. Qualification Data: For Installer and intrusion detection systems integrator.

B. Field quality-control reports.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

B. As-Built Documents: Upon completion of installation, the Contractor shall prepare "as-built" drawings of the system. These "As-builts" shall be 30 inches by 42 inches format reproducible drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
   1. Include final point-to-point wiring diagrams of each type of device.
   2. As-built drawings shall be submitted to the Owner for approval prior to the system acceptance walk-through.

C. Parts list.

1.08 QUALITY ASSURANCE

A. Manufacturer Qualification:
   1. The system shall be the standard product of one manufacturer, and the manufacturer shall have been in business manufacturing similar products for at least 5 years.
   2. Manufacturer's Quality System: Registered to ISO 9001:2000 Quality Standard.

B. Installer Qualification:
   1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
   2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   3. Layout Responsibility: Preparation of Shop Drawings by a Technician.
   4. Installation Supervision: Installation shall be under the direct supervision of Level 2 Commercial Installer, who shall be present at all times when Work of this Section is performed at Project site.
   5. Minimum of five years’ experience installing access control, surveillance and security systems and devices.
   6. After-sales support: The Contractor shall be a factory-authorized and trained dealer of the system and shall be factory-trained and certified to maintain/repair the system after system acceptance.

C. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
   1. At least one of whom is a Certified Systems Integrator.

D. Testing Agency Qualifications: Certified by BICSI.
   1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

E. System Requirements:
   1. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
      a. National Codes: NEC, NFPA, UBC, BOCA, SBCCI, IBC, as applicable.
      b. Approvals and listings: UL, ULC, FM, ANSI SIA CP-01, CSFM, as applicable.
      c. Local Authorities Having Jurisdiction (AHJ).

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers; and unharmed original identification labels.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Protect store materials from environmental and temperature conditions following manufacturer's instructions.

D. Handle and operate products and systems according to manufacturer's instructions.

1.10 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five (5) years from date of Substantial Completion.

B. Service/Maintenance:
   1. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).
   2. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.
   3. The installer shall correct any system defect within six hours of receipt of call from the Owner.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. A functionally complete, integrated Digital Alarm Communicator System (DACS) per manufacturer's guidelines, codes and specification requirements. The DACS shall include the following:
   1. Control Panel with built-in Ethernet jack for event communication and remote services.
   2. Control Panel with an optional, supervised telephone line interface module.
   3. Recording and retention of event information in a dedicated event log.
   4. Incorporate an integral real-time clock, calendar, and a test timer.
   5. Incorporate battery charging capabilities with supervision of battery voltage and battery leads.
   6. Time / event-based scheduling system.
   7. Capable of supervision of peripheral devices and communications interfaces.
   8. Accommodate configuration and operation of separate, independent areas.
   9. Accommodate hard-wired or wireless point expansion via eight-point interface modules and RF receivers.
   10. Accommodate addressable expansion utilizing a 2-wire bus.
   11. Incorporate removable terminal strips for wiring connection to facilitate simple service and replacement
   12. Electrically supervised detection loops and power supplies with battery(s) maintenance. This supervision shall be programmable for the purposes of reporting this information to the DACR.
   13. Capable of sending (manually or automatically) test and status reports to remote DACRs.
   14. Accommodate test, diagnostics, and configuration programming functions locally or remotely via a portable programmer or a computer running the Remote Programming Software (RPS).
   15. Annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English, Latin American Spanish, Portuguese and/or French Canadian text at the ACC.

2.02 MANUFACTURERS

A. Acceptable Manufacturer: Bosch Security Systems, Inc.; 130 Perinton Parkway; Fairport, NY 14450. ASD. Toll Free Tel: 800-289-0096. Tel: 585-223-4060. Email: request info (presales.support@us.bosch.com). Web: www.boschsecurity.us.

B. Substitutions: Not permitted.

2.03 SYSTEM COMPONENT REQUIREMENTS

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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:
   1. Door hardware specified in Division 08 Section "Door Hardware."
   2. Elevators specified in Division 14 Section "Hydraulic Elevators."
   3. Lighting controls specified in Division 26 Section "Networked Lighting Control."
   4. Access control system specified in Division 28 Section "Access Control System."
   5. Fire alarm system specified in Division 28 Section "Digital, Addressable, Voice Evacuation Fire-Alarm System."

D. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.
   1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Surge Protection for Low-Voltage Electrical Power Circuits."
   2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

E. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

F. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

G. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

H. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

I. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.04 CONTROL PANEL

A. The DACS control panel shall be Bosch Security Systems, Inc. model B9512G comprising a fully integrated intrusion system. The control panel shall support the following:
   1. The DACS control panel shall be Bosch Security Systems, Inc. model B9512G comprising a fully integrated intrusion system. The control panel shall support the following:
   2. Optional Telephone Line Module, programmable for signaling and supervision.
   3. Integrated Conettix IP based communication provides high-speed, secure alarm transport and control.

4. Thirty-two (32) programmable areas with perimeter and interior partitioning.
5. Eight (8) on-board, hardwired points with expansion capability for a total of 599 using a combination of wired or wireless points.
6. Compatibility with Color Graphic Touch Screen, 2-line alpha numeric capacitive touch, ATM style LCD or 2-line LCD style Alarm Keypads.
7. Local or remote programming, test, and diagnostic capability via a computer running the Remote Programming Software (RPS).
8. Integrated USB port for local programming and diagnostics using a computer running Remote Programming Software (RPS) and a male USB2.0 to male USB 2.0 cable with no additional hardware modules required.
9. Support the use of an Apple iOS device and/or Android device for control. Functions to include arming, disarming and control of outputs and access door, viewing of connected IP cameras. This application shall connect directly to the DACS using internet, wifi or cellular communications and shall not require a third-party server of network operations center (NOC).
10. Allow integration with up to 16 Bosch IP video cameras using the built-in Ethernet connection, allowing the cameras to act as inputs and outputs.
11. Support integration with the Bosch Video Management System (BVMS) using the built-in Ethernet adapter.
12. Support up to thirty-two (32) custom functions allowing the installer to combine up to 6 functions into one command. These custom functions shall be operated by keypad command, point activation, keyfob button, or programmable schedule.
13. Support up to 32 keypad shortcuts which allow the installer to define which commands are available at each keypad.
14. Offer multiple language support that can be assigned per keypad. Languages supported must include English, Latin American Spanish, Portuguese and/or Canadian French.
15. Support flash firmware upgrades of systems firmware for the control panel and peripherals, allowing for future updates.
16. Integrated real time clock, calendar, test timer and programmable scheduling capability for relay control and automatic execution of system functions based on a time / event.
17. Provide 1.4 amps of power for standby operation and 2.0 amps of alarm power, both rated at 12 VDC.
18. Three (3) configurable form ‘C’ wet or dry-contact relay outputs with expansion capability for up to an additional 472 dry-contact relay outputs.
19. Integrated battery charger with reverse hook up protection, battery supervision and battery deep discharge protection.
20. Supervision of peripheral devices and communications interface(s).

B. Point Functionality and Expansion:
   1. Each point in the system shall be programmable to provide the following type of response in the system:
      a. Always on (24-hour response).
      b. On when the system is Master Armed.
      c. Only on when the system is Perimeter Armed.
      d. Displays / Does Not Display at the ACC when the point is activated.
      e. Provides / Does Not Provide entry warning tone.
      f. Sounds / Does Not Sound audible alarm indication.
      g. The Point is bypassable / not bypassable.
      h. Alarm Verification with programmable verification time.
      i. Relay activation by Point.
      j. Provides / Does Not Provide "watch point" capability.
      k. Provides Swinger Bypass.

l. Defers Bypass Report.
m. Can return to the system after being force armed and then restoring.
n. Can return to the system after being bypassed and then restoring.
o. Keyswitch arming (maintained or momentary)
p. Activate by Custom Function
q. Activate following an output

2. The system shall support a programmable Monitor delay functionality for supervision of points during disarmed periods. These points may be programmed to ignore status from 1 to 60 minutes and will activate only if the point is off-normal for this time period.
3. The system shall support a programmable delay response functionality for supervision of points during armed or disarmed periods. These points may be programmed to ignore status from 1 to 60 minutes and will activate only if the point is off-normal for this time period.
4. The system shall support virtual points and outputs for customized programming of events
5. The DACS shall be capable of supporting "group zoning." Group zoning refers to the combining of points into a separately identifiable and separately annunciated (programmable text) areas.
6. The DACS shall be capable of allowing variable point response times via programming. Point response times shall be programmable over a range of 300 milliseconds to 4.5 seconds.
7. The DACS shall have the capability to expand up to 599 separately identifiable points, of which 8 are on-board and 472 are off-board wired, addressable or wireless points.
   a. The eight (8) on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   b. Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   c. Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.
8. The BACS shall have the capability to expand up to 99 separately identifiable points, of which eight (8) are on-board and 91 are off-board addressable points connected to multiplexed backbone trunks via wired modules and/or wireless receivers.
   a. The eight (8) on-board points shall be able to accommodate powered class B functionality using a powered loop interface module.
   b. Point Expansion Modules (Wired and Wireless) shall be able to be located remote to the main panel to a maximum distance of 1000 feet.
   c. Addressable modules shall be able to be located remote to the panel to a maximum of 500 feet.

C. Areas/Accounts:
1. Support 32 independent areas. Each of the 32 areas shall have custom text associated with the armed state, disarmed state and point-off-normal state.
2. Capability of assigning 1 to 4 account identifiers to the areas depending on the distribution of areas per account.
3. All of the areas must be capable of Master (All) and/or Perimeter (Part) arming (excluding predefined Interior protection).
4. Capability of logically grouping 1 or more points into an area, or conversely, dividing 2 or more points into two or more areas.
5. Any area shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
6. Areas shall be independently controlled by their corresponding ACC.
7. Area(s) shall accommodate assignment of independent account numbers to define annunciation, control, and reporting functions.

8. Capability of linking multiple areas to a shared area which may be automatically controlled (hallway or lobby).
9. Accommodate conditional area arming dependant on the state of other areas (master or associate). Any area can be configured for perimeter and interior arming, not requiring a separate area for this function.

D. Output Relay Expansion: The DACS shall provide the capability for output relay expansion using relay expansion modules. Independent control of relay functions by area shall be possible through programming assignments.
   1. The DACS shall be capable of activating 472 additional relay outputs for auxiliary functions based on its classifications (area vs. panel wide). Output Expansion Modules shall be able to be located remote to the main panel to a maximum distance of 1000 feet. Eight (8) relays (Form C) are to be provided per octo-relay module.
   2. The DACS shall be capable of controlling relays and automatically executing system functions based on a time / event scheduling program. The program can be hour, day of week or day of month based.
   3. Relays and other outputs may be programmed to follow up to 14 different area conditions or up to 12 panel conditions. Relays may also be programmed to follow individual points or groups of points.
   4. The DACS shall support 5 different types of alarm output selections: Steady, Pulsed, Temporal Code 3 and Temporal Code 4.

E. Scheduling: The DACS shall support scheduling capabilities with the following characteristics:
   1. Arm / Disarm specific area(s) based on open/close windows.
   2. Bypass / Unbypass point(s).
   3. Activate / Deactivate relay(s).
   4. Send test reports.
   5. Up to 4 programmable holiday schedules of 366 days each (includes leap year). Based on the holiday settings, different time windows for open/close and other system functions can be executed.
   6. Automatic adjustment of system clock for daylight savings time.

F. Alarm Keypads:
   1. The DACS shall accommodate connection with up to 32 ACCs, each capable of displaying custom English, Latin American Spanish, Portuguese or Canadian French text on a liquid crystal display.
   2. The Alarm Keypads shall accommodate viewing and configuration of system parameters including:
      a. Network Parameters:
         1) DHCP Enable/Disable for the selected network module.
         2) UPnP Enable/Disable for the selected network module.
         3) IP Address for the selected network module
         4) Subnet Mask for the selected network module.
         5) Default Gateway for the selected network module.
         6) Port Number for the selected network module - The module's port number shall range from 0 to 65,535.
         7) DNS Server Address for the selected module's DNS server IP address
         8) DNS Host Name for the selected module. The DNS host name shall contain up to 63 characters.
         9) AES Encryption Key Size – Enable/Disable encryption by selecting the AES encryption key size for the selected network module.
         10) AES Encryption Key String - The user shall be able to display, add and modify the AES encryption string based upon the key size previously configured for the selected network module.

b. Point Parameters:
   1) Point Selection between one and the maximum number of points in the control panel.
   2) Point Registration to allow system response from a specific physical point on any one of the expansion modules; On-board or Point expansion modules (wired or wireless)
   3) Wireless points shall be able to be enrolled in the system via an auto enrollment feature.
c. Event Routing Parameters to allow programming of up to 4 report routing groups as well as configuration of primary and secondary paths.

G. User Passcodes and Authority: Passcodes shall be programmable with authority levels to allow users to operate any or all areas.
1. Up to 2000 different passcodes shall be accommodated
2. Each passcode shall be 3 to 6 digits (variable) and be assigned a 32-character user name
3. User access to System features and functions shall be configurable based on 14 individually programmable levels of authority assigned to the user passcode. Additionally, the system shall have the capability to assign to the user passcode, a different authority level in each of the areas. A service passcode can be assigned to the servicing agent allowing the agent limited access to system functions. User-programmable / activated functions include:
   a. Arming the system: All areas, specific area(s) only, perimeter instant, perimeter delayed, perimeter partial, watch mode, and arming the system with a duress passcode.
   b. Disarming the system: All areas, specific area(s) only and disarming with a duress passcode.
   c. Viewing system status: Faulted points, event memory, bypassed points, area status and point status.
   d. Implementation functions: Bypass a point, unbypass a point, reset sensors, silence bell, activating relays, initiating the remote programming function locally to allow programming the system from a remote location.
   e. Testing the system: Local Walk test, Service Walk test, send report to remote DACR to check the telephone link, and programming the time and date for the next test report transmission.
   f. Change system parameters: ACC display brightness, system time and date, and add/delete/change passcodes.
   g. Extend the closing time of the system.
   h. Transmitting special alerts and activating audible and visible signals.
   i. Executing multiple commands / ACC keystrokes from a single Menu / Command List item. This function shall be able to have a 32 character (alphanumeric) title to identify it on the ACC display.
   j. Editing of time / event based scheduling program from the ACC.
   k. The DACS shall also provide a "service menu" to implement functions such as viewing and printing the system log, displaying the system firmware revision number, and defaulting (toggling) text displays between custom and default text displays for troubleshooting.
4. The DACS shall allow users to change their own user passcode from the Alarm Keypad (ACC). Managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
5. The DACS shall incorporate a programmable "Passcode Follows Scope" feature to allow users to arm or disarm only the area they are entering with one simple command or control all areas from one ACC.

H. Communication: The DACS shall be capable of reporting system events and supervisory reports including alarm, trouble, missing modules, restorals, system status, AC failure, battery status to primary and secondary off-site DACR's. The following features shall be supported.
   1. Capable of communicating via dial-up analog telephone lines, over a LAN/WAN/Internet using a wired network interface module, or over a cellular network using a CDMA Cellular interface module.
   2. The Bosch Modem4 communications format shall be utilized for optimum system performance. The Modem4 format provides the maximum data information to the receiver for alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. The detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information. As an alternative format, Contact ID may be used although it will include less detailed information like point or user text.
   3. Capable of sending text (SMS) messages to compatible devices without requiring that these messages are sent to a monitoring center
   4. Capability of communicating with up to 8 different DACRs using up to 4 different phone numbers, up to 24-digits in length and/or 4 URL/IP addresses over a network.
   5. Report to a Commercial Central Station that is using a Bosch D6600 Receiver/Gateway or a Bosch D6100i Receiver using Modem4 as a preferred format or Contact ID as an alternate format.
   6. Provide the transmission information sent from the DACS that includes alarms, troubles, restorals, bypasses, relay activation, opening/closings, and card access. When using the ModemIIIa² format the detailed information includes the point numbers with text, peripheral device numbers, user numbers with text, and area information.
   7. The DACS reports shall be classified, by event, into ten subcategories or "report groups." Each group represents similar types of events. Individual events within each group shall be selectively enabled or disabled for transmission. The ten report groups shall be as follows:
      a. Burglar Reports.
      b. User Reports.
      c. Test Reports.
      d. Diagnostic Reports.
      e. Relay Reports.
      f. Auto Function Reports.
      g. RPS Reports.
      h. Point Reports.
      i. User Change Reports.
      j. Access Reports.
   8. Capability to verify the integrity of the remote communications path and switch to alternate paths when a communications failure occurs.
   9. Capable of unattended mode of operation whereby programming and configuration updates are automatically transferred using the Remote Programming Software (RPS). These updates can initiate from either the control panel or the remote computer using RPS.

I. Network Communication: The DACS shall be capable of network communications over a LAN, WAN, Intranet, or the Internet. The system shall include supervision of the network communication utilizing configurable periodic heartbeats to the Digital Alarm Communications Receiver (DACR). The DACR shall provide notification of the loss of communications from a networked system after a programmable timeframe since the last communication. The notification options shall be programmable and include local annunciation or indication to automation software.
   1. The network interface module shall be capable of supporting Dynamic Host Communication Protocol (DHCP) to obtain an IP Address.

2. The system shall support a method of authentication between the control panel and the receiver to ensure that the control panel has not been compromised or replaced.
3. The network interface modules shall be capable of supporting encryption using a minimum of 256-bit AES Encryption (Rijndael) certified by NIST (National Institute of Standards and Technology) utilizing the Cipher Block Chaining (CBC) method.
4. The network interface module shall support a 10/100BaseT connection to an Ethernet network.
5. The control panel shall be capable of network communication with a programmable poll time to send periodic heartbeats to the receiver, programmable ACK Wait time, and programmable retry time. In the situation where a communication path is unsuccessful, the control panel shall be capable of attempting backup communication through an available communication method to the same receiver or a backup receiver.
    a. The control panel shall have the ability to automatically adjust the heartbeat rate of a backup path that is using cellular to the heartbeat rate of the primary path in case of a primary path failure. Upon restoral of the primary path, the heartbeat rate of the backup path shall automatically restore to the original rate. This allows a system utilizing cellular communications to keep the wireless charges low.
    b. The network communication between the control panel and the receiver shall use Modem4 or Contact ID.
    c. The control panel shall be capable of two-way communication using a wired network interface module with a 10/100BaseT on a LAN/WAN/Internet configuration or with a cellular module on the Internet.
    d. The control panel shall be capable of configuring the destination of the receiver using a URL or static IP Address.
    e. The control panel shall be capable of using DNS to lookup the IP Address of the receiver when programmed with a URL.
    f. The control panel shall support UPnP for automated Port Forward configuration in the router where the control panel is installed.
    g. The control panel shall support AutoIP to enable the RPS software to connect to the control panel locally using an IP Direct connection.
    h. The control panel shall support configuration of the IP parameters from the keypad eliminating the need for a PC to configure the IP device.
    i. The control panel shall support network diagnostics from a keypad to allow local testing of network connectivity. The diagnostics should include, Ethernet cable connected, gateway configuration ok, DNS lookup operational, and external network connectivity (such as the Internet) operational.
    j. The system shall be capable of meeting DCID 6/9 and UL 2050 standards.

J. Event Log: The DACS shall maintain a log of events indicating time, day, month, year type of event, account number, area number, user ID, point text, user text and primary/secondary event route. The system shall allow the following characteristics:
1. The DACS shall be capable of storing up to 10,000 events
2. The DACS shall support viewing of logs locally at the ACC and remotely via an upload to a remote central station computer running the RPS software.
3. The DACS shall provide notification via a report to the DACR when the event log reaches a programmable “percent full capacity". This allows retrieval of stored events via RPS to prevent any loss of event history.
4. Group, signal type and area can route events to specific receivers.
5. Each DACR shall be designated as a primary, backup, or duplicate destination for each report group. Assigning an event to multiple routing groups provides for duplicate destinations for the event. The transmission of grouped events allows the reporting of different types of information to different remote DACRs.

K. Testing, Diagnostic, and Programming Facilities: The DACS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
   1. The DACS shall be capable of sending automatic tests daily, weekly or once every 28 days. Automatic test times shall be programmable to provide an offset of up to 24 hours from the current time.
   2. Automatic test reports shall be programmable to be deferred by one test interval if any other report is transmitted in the current interval.
   3. Automatic test reports and remote system access for diagnostics shall be supported via a remote central station computer with Remote Programming Software (RPS).
   4. The DACS shall be programmable locally or remotely. Programming shall be accomplished via a Keypad or a computer with a remote programmer and diagnostic software package (RPS).
   5. The DACS shall allow an on-site user to initiate remote programming while on-line with the servicing location. The remote programming device must provide a compare feature and allow for downloading either the stored program or the (un)modified program copied from the panel.
   6. The DACS shall allow the local programming option to be disabled and must provide a method to program a panel while no one is on premises, when the panel shares a line with an answering machine.
   7. The DACS shall accommodate IP Diagnostic to verify settings and operation of the network interface modules; Host name, MAC address, IPV4 address assignment. The IP Connection test shall include; Link test to verify physical cable integrity, Ping test to verify gateway response, ping test to verify address on the internet.
   8. Wireless point diagnostics shall include signal strength and device states of registered wireless points in the system.
   9. The number of system testing and programming sessions shall be restricted via the use of program locking features and passwords. Passcode protection in excess of sixteen million combinations is required.
   10. New modules support enhanced diagnostics through RPS

L. Miscellaneous Features: Programmable alarm output timer, 4 programmable entry delay times, exit delay programmable by area, individually programmable point of protection text, point bypassing, key switch arming capability with LED outputs.

M. False Alarm Reduction: The DACS shall comply with all ANSI SIA CP-01 2010 requirements for false alarm reduction

N. Ambush Detection: The DACS shall include an early ambush feature that requires that the user disarm, and then inspect the facility within a specified time period, before entering their passcode or a different authorized passcode again. If the user does not enter a passcode a second time, a duress event is generated. If the user does enter a passcode within the specified time period, the system disarms.

O. Two Man Rule: The DACS shall include a programmable feature that requires 2 separate passcodes to be entered to disarm the system. After 1 passcode is entered, the system will prompt for a second passcode to be entered on the same ACC. Without the second passcode, the system shall not disarm.

P. Dual Authentication: The DACS shall support Dual Authentication by area. Areas programmed for Dual Authentication require activate of a card and a passcode to allow access to system functions, arm/disarm, or access control doors.

Q. Area Re-Arm: The System shall support programmable area re-arm time of 1 minute to 24 hours.

R. User-Programmable Features: The DACS shall provide a menu driven interface to provide a user-friendly command structure for programming / customizing the system to the operational criteria of the application. The DACS shall be capable of being operated via:
   1. The Command Structure.
   2. Menu / Command List.

2.05 SYSTEM INTERFACE REQUIREMENTS

A. Grounding: The Contractor shall properly earth ground the DACS to prevent electrostatic charges and other transient electrical surges from damaging the DACS panel.

B. Primary Power: The Contractor shall provide a dedicated 120 VAC power circuit to the DACS system. The 120 VAC is stepped down to power the DACS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.

C. Primary Power Supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station.
   1. The message can also be programmed to "tag-along" with another message transmitted to the central station.
   2. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.
   3. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 to 12-hour transmission delay

D. Secondary Power (Standby Battery): The Contractor shall provide adequate battery power as defined by the relevant application criteria, (UL 864 and UL 985 for alarm installations). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.

E. Secondary Power Supervision: When the secondary power source experiences a 85 percent depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.

F. Telephone Interface: The control panel in the DACS shall be equipped with an optional phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection.
   1. The telephone line interface shall conform with FCC rules (Title 47 C.F.R. part 68).
   2. When a telephone line is determined to be out of service by the DACS panel, the event will be annunciated locally on the ACC and transmitted to the central station over the alternate communications interface. The transmission delay of this message is programmable from ten to two-hundred forty seconds.

G. Ethernet Interface: The DACS shall include a integrated Ethernet interface module as the primary, or back-up means of communicating to a DACR.
   1. Built-in IP-based alarm transport, programming, and control
   2. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.
   3. 10BASE T or 100BASE T network connection
   4. Full-duplex and half-duplex support

H. Cellular Interface: The DACS may use a cellular radio module as the primary, or backup, means of communicating to a DACR. Up to 4 IP Addresses shall be available for routing system events. The supervision time shall be programmable with a range of 5 to 65,535 seconds. The module shall accommodate 128 and 256-bit AES encryption using CBC (Cipher Block Chaining) mode.

I. Auxiliary Function Control Interfaces: The DACS shall accommodate auxiliary functions such as activating bells, strobes, or lights and shall be accomplished using the optional application specific relay modules. These auxiliary interfaces shall be electrically isolated to avoid inter-system interferences or damage to the system.

J. Wiring: The contractor shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:
   1. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.
   2. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.
   3. Data wires shall not be enclosed in conduit or raceways containing AC power wires.
   4. Where EMI may interfere with the proper operation of the DACS circuits, twisted/shielded cable shall be used.

K. Environmental Conditions: The DACS shall be designed to meet the following environmental conditions:
   1. The system shall be designed for a storage temperature of -10° C to 70°C (14° F to 158°F).
   2. The system shall be designed for an operating temperature of 0° C to 50°C (32° F to 120°F).
   3. The system shall be designed for normal operation in an 85% relative humidity environment.
   4. The system shall meet or exceed the requirements of FCC rules Title 47 C.F.R. Part 15, Class B devices, and Part 68, IEC EMC directive

2.06 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, fiberglass.

D. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.07 ALARM KEYPADS

A. Bosch B920 keypad.

B. Description:
   1. Built-in proximity reader.
   2. Four inputs and one output.
   3. Built-in sounder that produces several distinct audible warning tones. Each audible tone sounds different so users can recognize an event by hearing its unique tone.

2.08 DOOR SWITCHES

A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields. Switches shall be double-pole, double-throw.

B. Flush-Mounted Switches: Unobtrusive and flush with surface of door frame.

C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

2.09 MOTION SENSORS

A. Manufacturer: Bosch ISC-PDL1-W18G-H Professional Series TriTech Motion Detector.

B. Description: Passive infrared and microwave Doppler radar detection.

C. Device Performance:
   1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
   2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive devices and notify adverse conditions affecting installation or subsequent operation.

B. Do not begin installation until unacceptable conditions are corrected.

C. If preparation is the responsibility of another installer, notify architect of unsatisfactory preparation before proceeding.

D. Ensure selected location is secure and offers protection from accidental damage.

E. Location shall provide reasonable temperature and humidity conditions, free from sources of electrical and electromagnetic interference.

F. Ensure power source is protected against accidental shutoff.

G. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:
   1. Installation criteria defined in these specifications and in the construction documents.
   2. Factory Representative can be the Bosch Security Systems Inc Security Dealer.
   3. Approved submittals.
   4. Applicable requirements of referenced standards.

H. The contractor shall provide the following services as part of the contract:
   1. Supervision of sub-contractors.
   2. Coordination of other contractors for system-related work (electrical contractor, finish hardware contractor, architect, and general contractor).
   3. Attending site construction/coordination meetings.
   4. Keeping updated construction drawings at the construction site.
   5. Meeting construction deadlines per the construction schedule.

I. Programming of the system shall include the following tasks:
   1. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).
   2. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
   3. Programming passcodes according to the authorities and functions defined by the owner.
   4. Other system programming tasks required by the owner. These additional programming requirements shall be coordinated between the owner and the contractor.
   5. Software of hardware should be the most current version upon installation, as well firmware shall be current version available upon commissioning of system.
   6. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components are fully operational.

7. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.
8. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.
9. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the contractor (pass/fail), and an empty column for recording findings during the walk-through.
10. During programming of the system, coordinate with Owner the actual final room numbers for labeling purposes. Do NOT use construction room numbers.

J. The contractor shall certify completion in writing and schedule the commissioning walk-through. The contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

3.02 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:
1. Electronic door hardware.
2. Access control.
3. Fire-alarm system.
4. Video surveillance.
5. Building automation system.

B. Building Automation System (BAS) Interface: Provide dry contact interface with BAS to allow BAS to know when building intrusion detection system is armed.

3.03 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Alarm Areas/Zones:
1. Provide a separate zone for the 4th floor administration offices area from the remainder of the building.

D. Field devices installation:
1. Alarm Keypads: Install keypads as indicated on Drawings.
2. Door Switches: Neatly install braided lead into door frame. Braided lead should not be installed to protrude from frame or cause an obstruction in the door operation. It is the Contractor’s responsibility to coordinate with the door installer before drilling and gain approval from the Owner on location and aesthetics of the installation.
3. Motion Sensors: Ceiling mount where indicated on Drawings or wall mount at 8-feet a.f.f.

E. Software of hardware should be the most current version upon installation, as well firmware shall be current version available upon commissioning of system.

3.04 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Division 27 Section "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Wires and Cables:
   1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
   2. 120-V Power Wiring: Install according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

F. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws.

3.05 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."
   1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
   2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

D. Installation contractor shall submit a written test report that the system has been 100 percent tested and approved. Final test shall be witnessed by the owner, engineer, electrical contractor, chief security officer, and performed by the installation contractor. Final test report shall be received and acknowledged by the owner prior to request for final payment.

E. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

F. Provide instruction to the owner's satisfaction with regard to proper use and operation of the system.

G. Determine and report all problems to the manufacturer's customer service department.

3.06 ADJUSTING

A. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).

B. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

C. The installer shall correct any system defect within six hours of receipt of call from the Owner.

3.07 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before substantial completion.

END OF SECTION

SECTION 28 4600
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

A. Design and Provide a complete new fire alarm system for the new Tomball ISD High School facility.

B. Fire alarm system shall incorporate Emergency Voice Alarm and Communication System (EVACS) style notification.

C. Section Includes:
   1. Fire Alarm System Delegated Design
   2. Fire Alarm System Installation, including all components, wiring, and conduit.
   3. Transmitters for communication with supervising station.
   4. Maintenance of fire alarm system under contract for specified warranty period.

1.02 DEFINITIONS

A. AHJ: Authority (or Authorities) Having Jurisdiction.

B. EVACS: Emergency Voice Alarm Communication System as defined in NFPA 72, also known as "Voice Evacuation"

C. FAA: Fire Alarm System Annunciator

D. FACP: Fire Alarm Control Panel

E. FPP: Licensed Fire Alarm Planning Professional.

F. HVAC: Heating, Ventilating, and Air-Conditioning

G. NICET: National Institute for Certification in Engineering Technologies

H. UON: Unless Otherwise Noted

1.03 REFERENCE STANDARDS

Standards referenced below shall be current edition including all revisions, UON.

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.

B. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits 2002 (Corrigendum 2012).

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 72 - National Fire Alarm and Signaling Code Most Recent Edition Cited by Referring Code or Reference Standard.

G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

H. NFPA 101 - Life Safety Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems Current Edition, Including All Revisions.

J. UL 268A - Standard for Smoke Detectors for Duct Application Current Edition, Including All Revisions.

K. UL 521 - Standard for Heat Detectors for Fire Protective Signaling Systems Current Edition, Including All Revisions.

L. UL 864 - Control Units and Accessories for Fire Alarm Systems Current Edition, Including All Revisions.

M. UL 1480 - Standard for Speakers for Fire Alarm and Signaling Systems, Including Accessories Current Edition, Including All Revisions.

N. UL 1971 - Standard for Signaling Devices for the Hearing Impaired Current Edition, Including All Revisions.

1.04 ACTION SUBMITTALS

A. Delegated Design Submittal: Contractor shall perform all planning, calculations, etc. necessary for a complete fire alarm design, and prepare and submit to Authority Having Jurisdiction all documentation required for plan review and permitting, including but not limited to floor plans, riser diagrams, and description of operation.

B. Qualifications and Product Data:
   1. Copy (if any) of list of data required by authority having jurisdiction.
   2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
   3. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
   4. Evidence of designer qualifications.
   5. Evidence of installer qualifications.
   6. Evidence of instructor qualifications; training lesson plan outline.
   7. Evidence of maintenance contractor qualifications, if different from installer.

C. Shop Drawings and Design Calculations:
   1. Shop drawing submittal shall be approved by AHJ prior to submission to Architect & Engineer.
   2. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
   3. System zone boundaries and interfaces to fire safety systems.
   4. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
   5. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
   6. List of all devices on each signaling line circuit, with spare capacity indicated.
   7. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.

1.05 CLOSEOUT SUBMITTALS

A. Inspection and Test Reports:
   1. Submit inspection and test plan prior to closeout demonstration.
   2. Submit documentation of satisfactory inspections and tests.
   3. Submit NFPA 72 "Inspection and Test Form," filled out.

B. Operating and Maintenance Data: See Section 01 7800 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
   1. Complete set of specified design documents, as approved by authority having jurisdiction.
   2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
   3. Contact information for firm that will be providing contract maintenance and trouble call-back service.

4. List of recommended spare parts, tools, and instruments for testing.
5. Replacement parts list with current prices, and source of supply.
6. Detailed troubleshooting guide and large scale input/output matrix.
7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

C. Project Record Documents: Have one set available during closeout demonstration:
1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

D. Closeout Documents:
1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
3. Maintenance contract.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
2. In addition to the items in quantities indicated in PART 2, furnish the following:
a. All tools, software, and documentation necessary to modify the fire alarm system using Owner's personnel; minimum modification capability to include addition and deletion of devices, circuits, and zones, and changes to system description, operation, and evacuation and instructional messages.
b. One copy, on USB Flash Media, of all software not resident in read-only-memory.
c. Spare Lamps for Remote Indicating Lamp units: One unit, or 5% of the quantity of remote indicating lamp units installed, whichever is greater.
d. Spare Lamps for Strobe Units: One unit, or 5% of the quantity of strobes and horn strobes installed, whichever is greater.
e. Extra Fuses: Two for each size of installed fuse; Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.07 QUALITY ASSURANCE

A. Designer (Fire Alarm Planning Professional) Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by installing Contractor.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.

C. Maintenance Contractor Qualifications: Same entity as installer.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

1.08 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

B. Coordinate the work of this section with the work of other sections, including sprinkler systems, elevators, HVAC systems, and security/door locking systems.

1.09 WARRANTY

A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Units and Accessories:
1. Carrier Fire & Security Solutions/Edwards; EST4 Series (Basis of Design).
2. Honeywell Security & Fire Solutions/Notifier; Owner-Approved alternate manufacturer. Provide panel substantially equal in capability to the Basis of Design.

B. Initiating Devices and Notification Appliances:
1. Same manufacturer as control units.

C. No Substitutions except by written written approval from Owner and Engineer

2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
1. Provide all components necessary for a fully operational system in accordance with AHJ-approved design, applicable prescriptive codes, and design notes on contract drawings.
2. Protected Premises: Entire building shown on drawings.
3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
   a. ADA Standards.
   b. The requirements of the local authority having jurisdiction , which is Harris County Fire Marshall's Office.
   c. Applicable local codes.
   d. Contract Documents (drawings and specifications).
   e. NFPA 101.
   f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
4. Evacuation Alarm: Single smoke zone; general evacuation of entire premises.
5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
6. Program notification zones and voice messages as directed by AHJ.
7. Fire Alarm Control Unit: New, located at main telecommunication equipment room (MDF).

B. Supervising Stations and Fire Department Connections:

1. Public Fire Department Notification: By on-premises supervising station.
2. On-Premises Supervising Station: Existing proprietary station operated by Owner, located at _____.
3. Remote Supervising Station: UL-listed central station under contract to facility.
4. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), VoIP with Cellular Backup.

C. Circuits:
1. Initiating Device Circuits (IDC): Class B.
2. Signaling Line Circuits (SLC): Class B.
3. Notification Appliance Circuits (NAC): Class B.
4. Pathway Survivability: Level 0.

D. Spare Capacity:
1. Notification Appliance Circuits: Minimum 25 percent spare capacity.
2. Speaker Amplifiers: Minimum 25 percent spare capacity.
3. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.

E. Power Sources:
1. Primary: Dedicated branch circuits of the facility normal power distribution system.
2. Secondary: Storage batteries.
3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 FIRE SAFETY SYSTEMS INTERFACES

A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
1. Sprinkler water control valves.
2. Dry-pipe sprinkler system pressure.
3. Dry-pipe sprinkler valve room low temperature.
4. Elevator shut-down control circuits.

B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
1. Sprinkler water flow.
2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
3. Elevator lobby, elevator hoistway, and elevator machine room smoke detectors.

C. Elevators:
1. Elevator lobby, hoistway, and machine room smoke detectors: Elevator recall for fire fighters' service.
2. Elevator Machine Room Heat Detector: Shut down elevator power prior to hoistway sprinkler activation.
3. Sprinkler pressure or waterflow: Shut down elevator power prior to hoistway sprinkler activation.

D. HVAC:
1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers.
2. Smoke and Fire/Smoke Damper Actuators: Close dampers, shut down air handlers.

E. Doors:
1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 7100.
2. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 08 3323.

2.04 COMPONENTS

A. General:
   1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
   2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.

B. Fire Alarm Control Units: Digital, addressable type; listed, classified, and labeled as suitable for the purpose intended.

C. Master Fire Alarm Control Panel (FACP):
   1. Field-programmable, microprocessor-based, modular, power-limited design.
   2. Software, programs, system database, event history, etc. shall be held in non-volatile system memory to retain information through failure of primary and secondary power supplies.
   3. FACP shall include a real-time clock for time annotation of events.
   4. FACP shall provide a minimum 500-event history log.
   5. Complying with UL 864.
   6. Display: Graphical LCD type.
   7. Digital Alarm Communicator Transmitter (DACT):
      a. DACT shall be acceptable to the remote central station and comply with UL 632.
      b. Communicator shall monitor communication line status, conduct automatic self-tests and initiate a System Trouble signal if service is lost.
      c. Communicator shall provide local annunciation and display capabilities for local testing and troubleshooting.
      d. Secondary Power: Communicator shall be provided with integral rechargeable battery and automatic charger.
   8. Network Communications:
      a. Provide network communications and accessories as needed for fire alarm system IP communication to central station according to fire alarm manufacturer's written requirements.
      b. Provide inegration gateway using BACnet for connection to building automation system.
   9. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
      a. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
   10. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
      a. Batteries: Sealed lead calcium.
      b. Sufficient capacity to provide power for entire system upon loss of normal AC power for a period of 24 hours with 15 minutes of alarm signaling at end of this 24-hour period, as required by NFPA 72, Local Systems.

D. Remote Annunciator(s): at main reception, central plant, and each concession stand building.
   1. Display and user interface located remotely from main control panel.
   2. Signals annunciated and functions available at annunciator shall match those of FACP for alarm, including alarm / supervisory / trouble indications, acknowledging, silencing, resetting, and testing.
   3. Each annunciator shall be provided with a remote microphone for EVACS ana

E. Addressable Modules:

1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.
3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
4. Releasing Control Modules: Provide as indicated or as required for control of listed solenoids in releasing applications.
5. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
6. Signaling Line Circuit (SLC) Isolating Modules: Provide as indicated or as required to automatically isolate short circuits on connected sections of SLC loops and allow other sections to continue to function normally. Provide automatic reset upon correction of short circuit.

F. Initiating Devices:
   1. Addressable Systems:
      a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
      b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
   2. Manual Pull Stations: Only at attended locations as indicated on drawings.
      a. Spares: Provide 1 extra.
      b. Pull Station Local Alarm Cover: At each pull station, provide a factory-fabricated clear plastic cover with top hinge and integral, battery-powered local alarm. Lifting cover actuates alarm to discourage false-alarm operation of pull station. Safety Technology International #Stopper II series or equal.
   3. Smoke Detectors & Detector Bases: In each storage room, covering paths of egress, and all other locations required per prescriptive code. Refer to prescriptive codes referenced for detailed requirements.
      a. Detectors shall be twist-lock mounted to a fixed base wiring module, allowing replacement of detector without disturbing permanent wiring.
      b. Comply with UL 268.
      c. Spares: Provide 1 spare or 5% of quantity installed, whichever is greater.
   4. Duct Smoke Detectors: At air handling equipment > 2000 CFM as required by code.
      a. Detectors shall be twist-lock mounted to a fixed base wiring module and sampling enclosure, allowing replacement of detector without disturbing permanent wiring.
      b. Weatherproof Duct Housing Enclosure: NEMA 250, type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC ducts.
      c. Sampling Tubes: Design as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
      d. Relay Fan Shutdown: Programmable relay rated to interrupt fan motor control unit.
      e. Comply with UL 268A.
      f. Spares: Provide 1 extra.
   5. Heat Detectors & Detector Bases: In kitchens, break rooms, and other locations where fire detection is required but smoke detection is subject to a high probability of false alarms. See prescriptive codes referenced for detailed requirements.
      a. Detectors shall be combination-type, programmable to actuate by either fixed temperature or rate-of-rise unless otherwise indicated.
      b. Detectors shall be twist-lock mounted to a fixed base wiring module, allowing replacement of detector without disturbing permanent wiring.

c. Comply with UL 521.
d. Spares: Provide 1 spare or 5% of quantity installed, whichever is greater.

G. Notification Appliances:
1. Bells: At each fire protection sprinkler system entry. See prescriptive codes referenced for detailed requirements..
2. Speaker/Strobes: In accordance with applicable prescriptive codes..
a. Combination device meeting same specifications and requirements as individual devices described below.
b. Spares: Provide 1 extra.
3. Speakers: In accordance with applicable prescriptive codes..
a. Voice notification appliances complying with UL 1480.
b. Locate speakers for voice notification to meet the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
1) High-range Units: 2 to 15 W
2) Low-range Units: 1 to 2 W.
3) Matching Transformers: Tap range matched to acoustical environment of speaker location.
c. Spares: Provide 1 extra.
4. Strobes: In accordance with applicable prescriptive codes..
a. Xenon strobe lights complying with UL 1971.
b. Rated light output: 15, 30, 75, or 110 cd, selectable in the field.
c. Where wireguards or other protective covers are used, light output ratings required shall be calculated with guards in place.
d. Flashing pattern shall be synchronized as prescribed in ADA Standards.
e. Spares: Provide 1 extra.
5. Provide ceiling-mounted notification appliances except where ceilings are not present or noted on drawings to be free of devices. Refer to architectural plans for ceiling types, heights, and keep-out zones.
6. Provide wireguards in gyms and other areas where devices may be subject to physical damage.

H. Magnetic Door Holders
1. Provide wall-mounted electromagnetic type hold-opens complete with matching doorplates at locations indicated on technology drawings.
2. Units shall require no more than 3 W to develop 25-lbf holding force.
3. Material and finish: match door hardware.

I. Electromechanical Door Holders
1. Provide door-mounted electromechanical type hold-opens (integrated into door closer) at locations indicated on technology drawings.
2. Material and finish: match door hardware.

J. Remote Power Supply Units for Peripherals
1. Where required by the fire alarm system manufacturer, remote power supplies shall be provided that will provide sufficient current to drive audio/visual or other required devices.
2. These units shall be located in electrical closets, mechanical rooms or similar spaces. They shall not be installed in finished areas, storage rooms, etc., without the permission of the Engineer. All locations shall be indicated on the shop drawing submissions.
3. Remote power supplies shall be provided with local intelligence compatible with the digital multiplex network, so they have a unique address, providing the ability to monitor the supply for loss of power, shorts, grounds an d other supervisory functions.

4. Provide dedicated 120-volt power circuit(s) from nearby panelboards as required, whether indicated on the plans or not.

K. Circuit Conductors: Copper or optical fiber; color code and label.
   1. Interconnection cabling between buildings shall be optical fiber. No exceptions except by written approval of Owner and Engineer.

L. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
   1. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.

M. Locks and Keys: Deliver keys to Owner.

N. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
   1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
   2. Provide one for each control unit and/or annunciator where operations are to be performed.
   3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
   4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
   1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer’s instructions.

C. Handling: Protect materials from damage during handling and installation.

3.03 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, AHJ requirements, and Contract Documents.

B. Pathways:
   1. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
      a. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
   2. Pathways shall be installed in EMT.
   3. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

D. Install manual fire-alarm box(es) in the normal path of egress within 60 inches of the exit doorway, between 42 inches and 48 inches above floor level.
   1. Provide "Stopper II" (or equal) covers on all manual stations except the manual station installed directly adjacent to the fire alarm control panel.

E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

F. Install framed instructions in a location visible from fire-alarm control unit.

G. Grounding:
   1. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
   2. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.04 PARTIAL SEQUENCES OF OPERATION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   1. Manual pull stations.
   2. Smoke detectors.
      a. Provide UL-Listed alarm verification feature. Activate an approved "alarm verification" sequence at FACP and detector as prescribed by UL 864.
   3. Heat detectors.
   4. Automatic sprinkler system water flow.
   5. Fire-extinguishing system operation.
   6. Kitchen Hood fire suppression system.

B. Initiation of fire alarm signal shall automatically perform the following actions:
   1. Annunciate alarm condition and specific initiating device addressable point at FACP and FAA(s).
   2. Sound a distinctive voice-message evacuation signal throughout the zone(s) in alarm in accordance with NFPA 72 public mode alarm prescriptive requirements.
   3. Activate flashing visual strobe alarm assemblies in accordance with NFPA 72 public mode alarm prescriptive requirements.
   4. Unlock electric door locks in designated egress paths.
   5. Release fire and smoke door hold-open devices.
   6. Switch HVAC controls to fire alarm mode & shut down HVAC equipment rated 2000 cfm or greater that circulate air in the zone(s) in alarm in accordance with NFPA 90A.
   7. Recall elevators to primary or alternate recall floors.
   8. Transmit alarm message to remote supervising station in accordance with NFPA 72.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
   1. Valve supervisory switch(es).
   2. Duct smoke detectors.
   3. User disabling of zones or individual devices.
   4. Loss of communication with any panel on the network.

D. Trouble signal initiation shall be by one or more of the following devices and actions:
   1. Open circuits, shorts, and grounds in designated circuits.
   2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
   3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.

4. Loss of primary power at FACP.
5. Break in standby battery circuitry
6. Failure of battery charging.
7. Abnormal position of any switch at FACP or annunciator.
8. Voice signal amplifier failure.

E. Initiation of supervisory or trouble signal shall automatically perform the following actions:
1. Annunciate supervisory or trouble condition and specific addressable point(s) at FACP and FAA(s).
2. Sound a distinctive audio alert at panel and annunciator locations.
3. After a time delay of 200 seconds, transmit a supervisory or trouble signal to remote supervising station in accordance with NFPA 72.

3.05 INSPECTION AND TESTING FOR COMPLETION

A. Field tests shall be witnessed by Authority Having Jurisdiction. Notify AHJ and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

D. Provide all tools, software, and supplies required to accomplish inspection and testing.

E. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
1. Visual Inspection: Conduct visual inspection prior to testing.
a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

F. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.06 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:
1. Hands-On Instruction: On-site, using operational system.
2. Classroom Instruction: Contractor furnished classroom, on-site or at other local facility.

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session post-occupancy.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session post-occupancy.

D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.07 MAINTENANCE

A. See Section 01 7000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

B. Provide to Owner, at no extra cost, a written maintenance contract for entire manufacturer's warranty period, to include the work described below.

C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
   1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
   2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
   3. Record keeping required by NFPA 72 and authorities having jurisdiction.

D. Provide trouble call-back service upon notification by Owner:
   1. Provide on-site response within 2 hours of notification.
   2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
   3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.

E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.

G. Comply with Owner's requirements for access to facility and security.

3.08 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years 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 access to system and to upgrade computer equipment if necessary.

D. Installer shall provide a backup copy of the installed program database on USB drive upon completion of the project. They shall also provide the current version for the panel provided.

END OF SECTION

PLANNING
ENGINEERING
PROGRAM MANAGEMENT

Date: 11-08-2023 11:00 A.M
Project: Tomball ISD – RFQ #947-23 TWC – High School
Topic: Pre-Proposal Meeting
Sign-in Sheet

Name - printed	Company/Organization	Phone	Email
Robert Wilbanks	LAN	832-570-7978	rwwilbanks@lan-inc.com
CHRIS MASSEY	HELLAS	737 900-9579	Cmassey@hellasconstruction.com
Marcos Segovia	LECS Electrical	281-897-9775	marcos@lecs.net ~~www.lecs.net~~
ROGELIO MEDELLIN	LECS ELECTRICAL	281-897-9775	RMEDELLIN@LECS.NET
EUNICE HENDERSON	A-LERT ROOF	713-206-3444	EHENDERSON@CENTURIONINC.NET
Jordan Baird	Skanska	254-534-0041	jordan.baird@skanska.com

PLANNING
ENGINEERING
PROGRAM MANAGEMENT

Date: 11-08-2023 11:00 A.M
Project: Tomball ISD – RFQ #947-23 TWC – High School
Topic: Pre-Proposal Meeting
Sign-in Sheet

Name - printed	Company/Organization	Phone	Email
Robert Wilbanks	LAN	832-570-7978	rwwilbanks@lan-inc.com
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Mike Schulte	Schulte Roofing Inc	979.412.2118	mike@schulteroofing.com
Todo Granado Brian Wildish Andrew Janczak	Satterfield & Pontikes S & P Satterfield & Pontikes	832 943 4208 971 888 3444 713 351 1662	tgranado@satpon.com houstonbids@satpon.com ajanczak@satpon.com
Robert Hubble	Texas Fire & Sound	832-816-7563	rhubble@TXFS.us
Connor McMurrow	AMSYS Innovative Solutions	612-839-7100	Connor@amsys.com
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JOSE QUEVEDO	Micro Integration	832.330.5226	jose@microint.com

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Robert Wilbanks	LAN	832-570-7978	rwwilbanks@lan-inc.com
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Jeff Schafer	ICI Construction	281 355 5151	bids@iciconstructioninc.com
Geoff Blanchard	H&H Skylight Fabricators	832-672-3919	gblanchard@hhskylights.com
Norman Schleff	Texas Fire + Sound	281-948-5050	NSchleff@TXFS.us
Javier Vela	Vela Bros Painting INC	(817)825 2038	admin@velabrosgmt.com
JARROD PORTELANCE	HARVEY BUILDERS	281-831-2543	JPORTELANCE@HARVEYBUILDERS.com
Paul Copenhaver	WJHW	817 614 4175	pcopenhaver@wjhw.com
Pam Haynes	Gamma	713-963-0086	phaynes@gammaconst.com

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