City of Manchester, NH, Department of Aviation

Manchester - Boston Regional Airport

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

City Procurement Requisition No. 2600049
FAA AIP No. 3-33-0011-TBD-2026

- **SPECIAL PROVISIONS TO THE STANDARD SPECIFICATIONS (Vol II): PROJECT REQUIREMENTS**

- **SPECIAL PROVISIONS TO THE STANDARD SPECIFICATIONS (Vol II): GENERAL CONDITIONS**

- **SPECIAL PROVISIONS TO THE STANDARD SPECIFICATIONS (Vol II): SUPPLEMENTAL CONDITIONS FOR AIRPORT IMPROVEMENT PROJECTS (AIP)**

- **TECHNICAL SPECIFICATIONS: PROJECT # 2600049**

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REQUEST FOR COMPETITIVE PROPOSALS

OCTOBER 2026

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City of Manchester - Department of Aviation

Manchester - Boston Regional Airport

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

SPECIAL PROVISIONS TO THE STANDARD SPECIFICATIONS:

PROJECT REQUIREMENTS

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SPECIAL PROVISION SECTION

01317 BLASTING

1.01 DESCRIPTION

Delete the specification section in its entirety. Blasting shall not be permitted.

END OF SECTION 01317

SPECIAL PROVISION SECTION 01520

FIELD OFFICE EQUIPMENT

1.01 SUMMARY

Delete the specification section in its entirety. Field Office Equipment shall not be required.

END OF SECTION 01520

City of Manchester - Department of Aviation

Manchester - Boston Regional Airport

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

SPECIAL PROVISIONS TO THE STANDARD SPECIFICATIONS:

GENERAL CONDITIONS



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SPECIAL PROVISION SECTION 00731

SPECIFICATIONS AND DRAWINGS

Replace section 1.02 of Section 00731 with the following:

1.2 SUMMARY OF THE ORDER OF PRECEDENCE

In case of conflicts between the contract documents the order of precedence shall be as follows:

a. Modifications or changes last in time are first in precedence.

b. Addenda.

c. Special Provisions to the Project Requirements.

d. Project Requirements.

e. Special Provisions to the General Conditions.

f. General Conditions.

g. Special Provisions to the Supplemental Conditions for AIP Projects.

h. Supplemental Conditions for Airport Improvement Program (AIP) Projects (For ATP Projects only).

i. Special Provisions to the Standard Specifications

j. Technical Specifications.

k. Drawings; between detailed drawings and standard plates bound within the specifications, the detailed drawings govern. In case of discrepancy, calculated dimensions will govern over scaled dimensions.

l. Cited standards for materials or testing.

m. Cited FAA advisory circulars.

n. In the event where provisions of codes, safety orders, contract documents, referenced manufacturer's specifications or industry standards are in conflict, the more restrictive and higher quality shall govern.

- Note: Should there be a conflict among the Project Requirements, the General Conditions, the Supplemental Conditions for AIP projects, and the Technical Specifications, or any of the associated Special Provisions, the most stringent will apply.

END OF SECTION 00731

SPECIAL PROVISION SECTION 00740

CONTROL OF MATERIALS

Replace Section 1.09 Engineer's Field Office with the following section:

1.09 ENGINEER'S FIELD OFFICE

An Engineer's Field Office will not be required on this project.

END OF SECTION 00740

SPECIAL PROVISION SECTION 00765

MEASUREMENT AND PAYMENT

1.17 PAYMENT APPLICATION FORMS

Replace subsection a. with the following:

a. Use AIA Document G702 and Continuation Sheets G703 as applicable for the Base Bid Lump Sum and Allowance Contract Items.

b. The Schedule of Values for progress payments shall be as follows or as otherwise approved by the Owner:

Pay Item 1) Final Design and Submittals

Pay Item 2) Replacement of Terminal Walkway HVAC Equipment: RTU-1

Pay Item 3) Replacement of Terminal Walkway HVAC Equipment: RTU-2

Pay Item 4) Replacement of Terminal Walkway HVAC Equipment: RTU-3

Pay Item 5) Replacement of Terminal Walkway HVAC Equipment: RTU-4

Pay Item 6) Replacement of Terminal Walkway HVAC Equipment: RTU-5

Pay Item 7) Temporary HVAC Measures (Allowance): This item may have sub-components Pay Item 7a, 7b, 7c, etc. based on negotiated scope of work

Pay Item 8) Replacement of Terminal Building HVAC Equipment: AHU-5

The installation sequence and applications for payment will not necessarily follow the numerical order of the Pay Items.

c. Application for payment for the Pay Item may be made following substantial completion including testing and acceptance by the Owner of the work complete and in place at each location.

END OF SECTION 00765

SPECIAL PROVISION SECTION 00822

INSURANCE REQUIREMENTS

REVISE Section 00822 of the General Conditions as follows:

1.1 INSURANCE

Replace third paragraph of Section 1.01 Insurance with the following CONTRACTOR agrees to maintain in full force and effect:

a. Coverages as described below:

COVERAGE	LIMIT OF LIABILITY
Commercial General Liability: Bodily and Personal Injury; Products and Completed Operations Coverage	Bodily Injury and Property Damage, Combined Limits of $2,000,000 each Occurrence, and $5,000,000 aggregate
Automobile Liability	$1,000,000 combined single limit for: (1) Any Auto or (2) All Owned, Hired, and Non-Owned Autos
Excess Liability Coverage, or Umbrella Coverage, for Commercial General Liability and Automobile Liability	$5,000,000.00
All-Risks or Builder's Risk	Not Applicable for this Project
Workers' Compensation	Statutory for Workers' Compensation
Aggregate Limits are per 12-month policy period unless otherwise indicated.	

b. At all times during the term of the Contract Agreement and any extensions or renewals, CONTRACTOR shall provide and maintain insurance coverage that meets the Contract Agreement requirements. Prior to beginning performance under this Contract Agreement or any extensions thereof, or at any time upon the AIRPORT'S request, or each time coverage is renewed or updated, the CONTRACTOR shall furnish to the AIRPORT current certificates of insurance, endorsements, all policies, or other policy documents evidencing adequate coverage, as necessary. CONTRACTOR shall be responsible for and pay (a) all premiums and (b) any claims or losses to the extent of any deductible amounts. CONTRACTOR waives any claim it may have for premiums or deductibles against the OWNER, its officers, agents, or employees.

c. Subcontractor's Commercial General Liability and Property Damage Insurance and Automobile Liability Insurance

d. The CONTRACTOR shall either: (a) require each of his/her subcontractors to procure, and to maintain during the life of his/her subcontract, Subcontractor's Public Liability and Property Damage Insurance and Automobile Liability and Property Damage Insurance of the types and amount specified above, or (b) insure the activities of all subcontractors under the CONTRACTOR's own policies as specified above.

e. Form of Insurance. The form of the insurance shall be approved by the AIRPORT; such approval (or lack thereof) shall never (a) excuse non-compliance with the terms of this Section, or (b) waive or estop the Owner from asserting its rights to terminate the Contract Agreement. The policy issuer shall (1) have a Certificate of Authority to transact insurance business in the State of New Hampshire, or (2) be an eligible non-admitted insurer in the State of New Hampshire and have a Best's rating of at least B+, and a Best's Financial Size Category of Class VI or better, according to the most current Best's Key Rating Guide.

f. Required Coverage. The Owner, AIRPORT and the Architect/Engineer shall be an Additional Insured under this Contract Agreement, and all policies, except Worker's Compensation, shall explicitly name the Owner, AIRPORT and Architect/Engineer as an Additional Insured. The Owner, AIRPORT and Architect/Engineer shall enjoy the same coverage as the Named Insured without regard to other contract provisions. CONTRACTOR waives any claim or right of subrogation to recover against the OWNER, its officers, agents, or employees. Each of CONTRACTOR'S insurance policies, except Worker's Compensation, must contain coverage waiving such claim. Each policy, except Workers' Compensation, must also contain an endorsement that the policy is primary to any other insurance available to the Additional Insured with respect to claims arising under the Contract Agreement.

g. Notice. CONTRACTOR SHALL GIVE 30 DAYS' ADVANCE WRITTEN NOTICE TO THE AIRPORT IF ANY OF ITS INSURANCE POLICIES ARE CANCELED OR NON-RENEWED. Within the 30-day period, CONTRACTOR shall provide other suitable policies in order to maintain the required coverage. If CONTRACTOR does not comply with this requirement, the AIRPORT, at their sole discretion, may immediately suspend CONTRACTOR from any further performance under the Contract Agreement and begin procedures to terminate the Contract Agreement for default.

h. SPECIAL HAZARDS:

The Contractor's and Subcontractor's Public Liability, Property Damage, Automobile Liability, and Automobile Property Damage insurance coverages shall provide adequate protection against the following special hazards:

1. Damage or injury to aircraft or persons in aircraft operating on or near the project site, resulting from any operations under this Contract.

2. Damage or injury resulting from the use, storage, handling or transportation of explosives in connection with the Contract work, as applicable.

i. The purchase of the insurance required or the furnishing of the aforesaid certificate shall not be a satisfaction of CONTRACTOR'S liability hereunder or in any way modify the CONTRACTOR'S indemnification responsibilities to the Owner, Authority or Architect/Engineers.

END OF SECTION 00822

SPECIAL PROVISION SECTION 00840

LIQUIDATED DAMAGES AND EXTENSIONS

Revise paragraph 1.01 LIQUIDATED DAMAGES as follows:

1.1 LIQUIDATED DAMAGES

REMOVE and REPLACE paragraph 1.01a with the following:

a. If the Contractor fails to substantially complete the Work and/or any intermediate phases of the work which may be required within the time specified in the Contract, or any extension, for reasons that are within the Contractor's direct control, the Contractor shall pay the Owner, or the Owner will deduct payments due under this Contract or any other contract with the Owner, as liquidated damages, the sum of **Zero dollars ($ 0.00)** for each calendar day of delay.

There will be **no liquidated damages assessed for this project** unless the Contract is specifically amended as may be agreed upon by the Parties.

END OF SECTION 00840

SPECIAL PROVISION SECTION 01380

CONSTRUCTION PHOTOGRAPHS

Replace the entire Section 01380 of the General Conditions, with the following:

1.1 QUALITY ASSURANCE

a. The Contractor shall utilize a digital camera with no less than 5 mega pixel resolution. The hiring of a professional photographer is not required on this project.

1.2 SUBMITTALS

a. The Contractor shall comply with pertinent provisions of Section 01340 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

b. Except as otherwise directed and paid for, the Contractor shall furnish photographs of the project, the views shall be as directed or approved by the Owner's Representative. The photographs shall show the project site prior to construction, the work in progress and the project site at the completion of work. A minimum of 25 color photographs will be taken during each weekly period of the contract that work on site is progressing at each location of the work.

c. Photos shall be taken at all areas that will be difficult to observe after additional work is installed, or areas that will be covered and unobservable, prior to the installation of the obstructive work. Digital files shall be provided to the Owner's Representative by the Contractor.

d. The image file names and folder organization shall be descriptive of the intended subject including:

1. Job name;
2. A descriptive subject and location from which photographed;
3. Date of photograph;
4. Photograph number.

e. The Contractor shall not permit prints or files to be issued for any other purpose without specific written approval from the Owner.

1.3 CONSTRUCTION PHOTOGRAPHY

a. Site Photographs

1. Each photograph shall be clear, in focus, with high resolution and sharpness, and with minimum distortion.
2. The Owner may direct the Contractor to change perspective, view, or areas to be photographed as the construction progresses.
3. Photographs taken by the Design-Builder's / Contractor's site

superintendent(s) with a cellphone and transmitted via email or cloud file-share transfer (such as a link to a SharePoint folder) will suffice for submittal. Submittal of electronic files on a CD will not be required unless the emailed (or cloud file-share) files have not been received.

4. The photographs required are intended to document the existing site conditions just prior to commencement of construction to clarify the Contractor's responsibility for site restoration and to specifically show progress of work that will be covered up or difficult to observe when construction is complete. They do not need to show every aspect of the work.

1.4 MEASUREMENT AND PAYMENT

a. There will be no separate measurement or payment for photos. All photos, prints, and electronic files are considered incidental to the work and will be provided at no additional cost to the Owner.

END OF SECTION 01380

SPECIAL PROVISION SECTION 01560

TEMPORARY CONTROLS

Add or amend the following to Section 01560 of the General Conditions:

1.01 DESCRIPTION

b. Dust and Dirt Control:

Add the following:

7. Contractor shall design, furnish and install dust protection in conjunction with the project work area barricades as required by the Technical Specifications to contain errant dust from dispersing outside the work areas into the terminal building.

END OF SECTION 01560

SPECIAL PROVISION SECTION 01590

CONTRACTOR'S FIELD OFFICE AND SHEDS

Amend Section 01590 of the General Conditions as follows:

1.01 DESCRIPTION

ADD the following paragraph:

a. The Contractor's field office, if necessary, shall be located remotely from the terminal building site as directed, and contractor employee POV parking shall be in Owner-designated areas, located offsite, in the parking garage at the Contractor's or employee's expense, or as otherwise directed by the Owners Representative. The field office and Contractor-owned work vehicle parking shall occur on Airport property. The Contractor shall obtain pre-approval of all locations.

END OF SECTION 01590

Manchester - Boston Regional Airport

City of Manchester - Department of Aviation

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

SPECIAL PROVISIONS TO THE STANDARD SEPCIFICATIONS:

SUPPLEMENTAL CONDITIONS FOR AIRPORT IMPROVEMENT PROJECTS (AIP)

OCTOBER 2026

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SPECIAL PROVISION SECTION 00820-AIP

REQUIRED FEDERAL CONTRACT PROVISIONS

Replace Section of 00820 of the Supplemental Conditions for AIP Projects with the following:

1.1 DESCRIPTION

Procurements made under the Airport Improvement Program shall comply with required Federal provisions established by various laws and statutes. The requirements for the provisions will vary depending on the type and size of the procurement action. Application of a certain provision also depends on established contract dollar thresholds. Note that exceeding several contract dollar thresholds causes additional provisions to be required in The City of Manchester, Department of Aviation contracts in each category of contract.

1.2 FEDERALLY FUNDED CONSTRUCTION CONTRACT PROVISIONS

The Required Federal Contract Provisions for the Federal Aviation Administration's Airport Improvement Program and their application thresholds are located in the attached **Appendix A Required Contract Provisions for Airport Improvement Program and Obligated Sponsors** in this Volume of the Project Documents. The Contractor shall adhere to all of the applicable provisions.

The Contractor, and all subcontractors, shall insert these contract provisions in each lower-tier contract (subcontract) including incorporation of the applicable requirements and shall be responsible for compliance with these contract provisions by any subcontractor, lower-tier subcontractor or service provider.

Also refer to Section 00320-AIP for the applicable forms of certification that shall be submitted as part of the Bid Proposal.

END OF SECTION 00820-AIP

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SECTION 00820-AIP ; APPENDIX-A

AIRPORT TERMINAL & WALKWAY HVAC EQUIPMENT REPLACEMENT PROJECT: 2600049

AIP 3-33-0011-TBD-2026

FAA Airports

Contract Provision Guidelines for Obligated Sponsors and Airport Improvement Program Projects

(Issued on March 17, 2026)

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ACCESS TO RECORDS AND REPORTS
(2 CFR § 200.333, 2 CFR § 200.337, FAA Order 5100.38)

CONTRACT CLAUSE

(Required for all FAA Airport Improvement Program funded projects)

The Contractor must maintain an acceptable cost accounting system. The Contractor agrees to provide the Owner, the Federal Aviation Administration and the Comptroller General of the United States or any of their duly authorized representatives access to any books, documents, papers and records of the Contractor which are directly pertinent to the specific contract for the purpose of making audit, examination, excerpts and transcriptions. The Contractor agrees to maintain all books, records and reports required under this contract for a period of not less than three years after final payment is made and all pending matters are closed.

BREACH OF CONTRACT TERMS
(2 CFR § 200 Appendix II(A))

(Required for all FAA Airport Improvement Program funded projects that exceed the simplified acquisition threshold)

CONTRACT CLAUSE

Any violation or breach of terms of this contract on the part of the ***Contractor*** or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement.

Owner will provide ***Contractor*** written notice that describes the nature of the breach and corrective actions the ***Contractor*** must undertake in order to avoid termination of the contract. Owner reserves the right to withhold payments to ***Contractor*** until such time the ***Contractor*** corrects the breach or the Owner elects to terminate the contract. The Owner's notice will identify a specific date by which the ***Contractor*** must correct the breach. Owner may proceed with termination of the contract if the ***Contractor*** fails to correct the breach by the deadline indicated in the Owner's notice.

The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

BUY AMERICAN PREFERENCE
(Title 49 USC § 50101, Executive Order 14005,
Infrastructure Investment and Jobs Act (IIJA) (Pub. L. No. 117-58), Build America, Buy America (BABA))

(Required for all FAA Airport Improvement Program funded projects)

FAA BUY AMERICAN PREFERENCE

The Contractor certifies that its bid/offer is in compliance with 49 USC § 50101, BABA and other related Made in America Laws,[1] U.S. statutes, guidance, and FAA policies, which provide that Federal funds may not be obligated unless all iron, steel and manufactured goods used in AIP funded projects are produced in the United States, unless the Federal Aviation Administration has issued a waiver for the product; the product is listed as an Excepted Article, Material Or Supply in Federal Acquisition Regulation subpart 25.108; or is included in the FAA Nationwide Buy American Waivers Issued list.

The bidder or offeror must complete and submit the certification of compliance with FAA's Buy American Preference, BABA and Made in America laws included herein with their bid or offer. The Airport Sponsor/Owner will reject as nonresponsive any bid or offer that does not include a completed certification of compliance with FAA's Buy American Preference and BABA.

The bidder or offeror certifies that all constructions materials, defined to mean an article, material, or supply other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives that are or consist primarily of: non-ferrous metals; plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); lumber; or drywall used in the project are manufactured in the U.S.

The bidder or offeror certifies procurement of certain rolling stock using FAA grant funds will prohibit airports from using Federal financial assistance to procure buses or rail car vehicle rolling stock from covered entities.

[1] Per Executive Order 14005 "Made in America Laws" means all statutes, regulations, rules, and Executive Orders relating to federal financial assistance awards or federal procurement, including those that refer to "Buy America" or "Buy American," that require, or provide a preference for, the purchase or acquisition of goods, products, or materials produced in the United States, including iron, steel, and manufactured products offered in the United States.

Certification of Compliance with FAA Buy American Preference – Construction Projects

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with its proposal. The bidder or offeror must indicate how it intends to comply with 49 USC § 50101, BABA and other Made in America Laws, U.S. statutes, guidance, and FAA policies, by selecting one of the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (i.e., not both) by inserting a checkmark (✓) or the letter "X".

☐ Bidder or offeror hereby certifies that it will comply with 49 USC § 50101, BABA and other related U.S. statutes, guidance, and policies of the FAA by:

a) Only installing iron, steel and manufactured products produced in the United States;
b) Only installing construction materials defined as: an article, material, or supply – other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives that are or consist primarily of non-ferrous metals; plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables); glass (including optic glass); lumber or drywall that have been manufactured in the United States.
c) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
d) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

a) To provide to the Airport Sponsor or FAA evidence that documents the source and origin of the iron, steel, and/or manufactured product.
b) To faithfully comply with providing U.S. domestic products.
c) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.
d) Certify that all construction materials used in the project are manufactured in the U.S.

☐ The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for a Type 3 or Type 4 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

a) To submit to the Airport Sponsor or FAA within 15 calendar days of being selected as the responsive bidder, a formal waiver request and required documentation that supports the type of waiver being requested.
b) That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination that may result in rejection of the proposal.
c) To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
d) To furnish U.S. domestic product for any waiver request that the FAA rejects.

e) To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

Required Documentation

Type 2 Waiver (Nonavailability) – The iron, steel, manufactured goods or construction materials or manufactured goods are not available in sufficient quantity or quality in the United States. The required documentation for the Nonavailability waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire

b) Record of thorough market research, consideration where appropriate of qualifying alternate items, products, or materials including;

c) A description of the market research activities and methods used to identify domestically manufactured items capable of satisfying the requirement, including the timing of the research and conclusions reached on the availability of sources.

Type 3 Waiver – The cost of components and subcomponents produced in the United States is more than 60 percent of the cost of all components and subcomponents of the "facility/project". The required documentation for a Type 3 waiver is:

a) Completed Content Percentage Worksheet and Final Assembly Questionnaire including;
b) Listing of all manufactured products that are not comprised of 100 percent U.S. domestic content (excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108; products of unknown origin must be considered as non-domestic products in their entirety).
c) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly and installation at project location.
d) Percentage of non-domestic component and subcomponent cost as compared to total "facility" component and subcomponent costs, excluding labor costs associated with final assembly and installation at project location.

Type 4 Waiver (Unreasonable Costs) – Applying this provision for iron, steel, manufactured goods or construction materials would increase the cost of the overall project by more than 25 percent. The required documentation for this waiver is:

a) A completed Content Percentage Worksheet and Final Assembly Questionnaire form
b) At minimum two comparable equal bids and/or offers;
c) Receipt or record that demonstrates that supplier scouting called for in Executive Order 14005, indicates that no domestic source exists for the project and/or component;
d) Completed waiver applications for each comparable bid and/or offer.

False Statements: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

Date	Signature
Company Name	Title

CIVIL RIGHTS - GENERAL
(49 USC § 47123)

(Required for ALL projects – regardless of Funding)

CONTRACT CLAUSES
GENERAL CIVIL RIGHTS PROVISIONS

In all its activities within the scope of its airport program, the Contractor agrees to comply with pertinent statutes, Executive Orders, and such rules as identified in Title VI List of Pertinent Nondiscrimination Acts and Authorities to ensure that no person shall, on the grounds of race, color, national origin, creed, sex, age, or disability be excluded from participating in any activity conducted with or benefiting from Federal assistance.

This provision is in addition to that required by Title VI of the Civil Rights Act of 1964.

The above provision binds the Contractor and subcontractors from the bid solicitation period through the completion of the contract.

CIVIL RIGHTS – TITLE VI ASSURANCES
(49 USC § 47123, FAA Order 1400.11)

(Required for ALL projects – regardless of funding)

TITLE VI SOLICITATION NOTICE:

The City of Manchester - Department of Aviation, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§ 2000d to 2000d-4), 28 CFR § 50.3, and 49 CFR Part 21, hereby notifies all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, all contractors will be afforded full opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of the owner's race, color, national origin, sex, creed, age, or disability in consideration for an award.

TITLE VI LIST OF PERTINENT NONDISCRIMINATION ACTS AND AUTHORITIES

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor") agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 USC § 2000d *et seq*., 78 stat. 252) (prohibits discrimination on the basis of race, color, national origin);
- 49 CFR part 21 (Non-discrimination in Federally-Assisted programs of the Department of Transportation—Effectuation of Title VI of the Civil Rights Act of 1964); including amendments thereto;
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 USC § 4601) (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);

- Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. § 794 *et seq*.), as amended (prohibits discrimination on the basis of disability); and 49 CFR part 27 (Nondiscrimination on the Basis of Disability in Programs or Activities Receiving Federal Financial Assistance);
- The Age Discrimination Act of 1975, as amended (42 U.S.C. § 6101 *et seq*.) (prohibits discrimination on the basis of age);
- Airport and Airway Improvement Act of 1982 (49 U.S.C. § 47123), as amended (prohibits discrimination based on race, creed, color, national origin, or sex);
- The Civil Rights Restoration Act of 1987 (P.L. 100-259) (broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, the Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms "programs or activities" to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- Titles II and III of the Americans with Disabilities Act of 1990 (42 U.S.C. § 12101, et seq) (prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities) as implemented by U.S. Department of Transportation regulations at 49 CFR parts 37 and 38;
- Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 U.S.C. § 1681, et seq).

TITLE VI CONTRACT CLAUSES
COMPLIANCE WITH NONDISCRIMINATION REQUIREMENTS

During the performance of this contract, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor"), agrees as follows:

1. **Compliance with Regulations:** The Contractor (hereinafter includes consultants) will comply with the Title VI List of Pertinent Nondiscrimination Acts and Authorities, as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.
2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, national origin, creed, sex, age, or disability in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21 including amendments thereto.
3. **Solicitations for Subcontracts, including Procurements of Materials and Equipment:** In all solicitations, either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the Contractor of the contractor's obligations under this contract and the Nondiscrimination Acts and Authorities on the grounds of race, color, or national origin.
4. **Information and Reports:** The Contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts and Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information,

the Contractor will so certify to the Sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.

5. **Sanctions for Noncompliance:** In the event of a Contractor's noncompliance with the non-discrimination provisions of this contract, the Sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:

    a. Withholding payments to the Contractor under the contract until the Contractor complies; and/or

    b. Cancelling, terminating, or suspending a contract, in whole or in part.

6. **Incorporation of Provisions:** The Contractor will include the provisions of paragraphs one through six in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations, and directives issued pursuant thereto. The Contractor will take action with respect to any subcontract or procurement as the Sponsor or the Federal Aviation Administration may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the Contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the Contractor may request the Sponsor to enter into any litigation to protect the interests of the Sponsor. In addition, the Contractor may request the United States to enter into the litigation to protect the interests of the United States.

CLEAN AIR AND WATER POLLUTION CONTROL
(2 CFR § 200, Appendix II(G), 42 USC § 7401, 33 USC § 1251)
(Required for all FAA Airport Improvement Program funded contracts and lower tier contracts that exceed $150,000)

Contractor agrees to comply with all applicable standards, orders, and regulations issued pursuant to the Clean Air Act (42 USC § 740-7671q) and the Federal Water Pollution Control Act as amended (33 USC § 1251-1387). The Contractor agrees to report any violation to the Owner immediately upon discovery. The Owner assumes responsibility for notifying the Environmental Protection Agency (EPA) and the Federal Aviation Administration.

Contractor must include this requirement in all subcontracts that exceed $150,000.

CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS (2 CFR § 200, Appendix II(E); 29 CFR § 5.5(b)(2); 29 CFR § 5.8(a); 40 USC § 3702(c); 40 USC § 3704)

(Required for all FAA Airport Improvement Program funded contracts and lower tier contracts that exceed $100,000 and employ laborers, mechanics, watchmen, and guards)

CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

1. Overtime Requirements.

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic, including watchmen and guards, in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; Liability for Unpaid Wages; Liquidated Damages.

In the event of any violation of the clause set forth in paragraph (1) of this clause, the Contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this clause, in the sum of $33 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this clause.

3. Withholding for Unpaid Wages and Liquidated Damages.

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this clause.

4. Subcontractors.

The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (1) through (4) and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1) through (4) of this clause.

COPELAND "ANTI-KICKBACK" ACT
(2 CFR § 200, Appendix II(D), 29 CFR Parts 3 and 5)

(Required for all FAA Airport Improvement Program funded construction contracts and subcontracts that exceed $2,000)

COPELAND "ANTI-KICKBACK" ACT

Contractor must comply with the requirements of the Copeland "Anti-Kickback" Act (18 USC 874 and 40 USC 3145), as supplemented by Department of Labor regulation 29 CFR part 3. Contractor and subcontractors are prohibited from inducing, by any means, any person employed on the project to give up any part of the compensation to which the employee is entitled. The Contractor and each Subcontractor must submit to the Owner, a weekly statement on the wages paid to each employee performing on covered work during the prior week. Owner must report any violations of the Act to the Federal Aviation Administration.

DAVIS-BACON REQUIREMENTS
(2 CFR § 200, Appendix II(D); 29 CFR Part 5; 49 USC§ 47112(b);
40 USC §§ 3141-3144, 3146, and 3147)

(Required for all FAA Airport Improvement Program funded construction contracts and subcontracts that exceed $2,000)

DAVIS-BACON REQUIREMENTS

1. Minimum Wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Secretary of Labor under regulations implementing the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalent thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination;

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the Contractor, the laborers, or mechanics to be employed in the classification, or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii) (B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, *Provided*, that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding. The Federal Aviation Administration or the Sponsor shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the Federal Aviation Administration may, after written notice to the Contractor, Sponsor, Applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and Basic Records.

(i) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act); daily and weekly number of hours worked; deductions made; and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records that show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual costs incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee

programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit the payrolls to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR § 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead, the payrolls shall only need to include an individually identifying number for each employee (*e.g*., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH–347 is available for this purpose from the Wage and Hour Division Web site at https://www.dol.gov/agencies/whd/government-contracts/construction/payroll-certification or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker and shall provide them upon request to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the Contractor will submit them to the applicant, Sponsor, or Owner, as the case may be, for transmission to the Federal Aviation Administration, the Contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, Sponsor, or Owner).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i), and that such information is correct and complete;

(2) That each laborer and mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages arned, other than permissible deductions as set forth in Regulations, 29 CFR Part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

(iii) The Contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the Sponsor, the Federal Aviation Administration, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the

Contractor, Sponsor, applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR § 5.12.

4. Apprentices and Trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR § 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at no less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work

actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

5. Compliance with Copeland Act Requirements.

The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

6. Subcontracts.

The Contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR §§ 5.5(a)(1) through (10) and such other clauses as the Federal Aviation Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR § 5.5.

7. Contract Termination: Debarment.

A breach of the contract clauses in paragraph 1 through 10 of this section may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR § 5.12.

8. Compliance with Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes Concerning Labor Standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

(i) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR § 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR § 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 USC § 1001.

DEBARMENT AND SUSPENSION
(2 CFR part 180 (Subpart B); 2 CFR part 200, Appendix II(H); 2 CFR part 1200; DOT Order 4200.5; Executive Orders 12549 and 12689)

(Required for all FAA Airport Improvement Program funded contracts expected to equal or exceed $25,000)

CERTIFICATION OF OFFEROR/BIDDER REGARDING DEBARMENT

By submitting a bid/proposal under this solicitation, the bidder or offeror certifies that neither it nor its principals are presently debarred or suspended by any Federal department or agency from participation in this transaction.

CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT

The successful bidder, by administering each lower tier subcontract that exceeds $25,000 as a "covered transaction", must confirm each lower tier participant of a "covered transaction" under the project is not presently debarred or otherwise disqualified from participation in this federally assisted project. The successful bidder will accomplish this by:

1. Checking the System for Award Management at website: **http://www.sam.gov**.
2. Collecting a certification statement similar to the Certification of Offeror/Bidder Regarding Debarment, above.
3. Inserting a clause or condition in the covered transaction with the lower tier contract.

If the Federal Aviation Administration later determines that a lower tier participant failed to disclose to a higher tier participant that it was excluded or disqualified at the time it entered the covered transaction, the FAA may pursue any available remedies, including suspension and debarment of the non-compliant participant.

DISADVANTAGED BUSINESS ENTERPRISE
(49 CFR part 26, 49 U.S.C. § 47113)

(Required for all FAA Airport Improvement Program funded projects)

SOLICITATION LANGUAGE (SOLICITATIONS WITH NO DBE CONTRACT GOAL)

The requirements of 49 CFR Part 26 including any amendments thereto apply to this contract. It is the policy of the **City of Manchester - Department of Aviation** to practice nondiscrimination based on race, color, sex, or national origin in the award or performance of this contract. The Owner encourages participation by all firms qualifying under this solicitation regardless of business size or ownership.

PRIME CONTRACT PROVISIONS

Contract Assurance (49 CFR § 26.13) –

The Contractor, subrecipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26, including any amendments thereto, in the award and administration of DOT-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:

1) Withholding monthly progress payments;
2) Assessing sanctions;
3) Liquidated damages; and/or
4) Disqualifying the Contractor from future bidding as non-responsible.

Prompt Payment (49 CFR §26.29) – The prime contractor agrees to pay each subcontractor under this prime contract for satisfactory performance of its contract no later than **thirty (30) calendar** days from the receipt of each payment the prime contractor receives from the **City of Manchester - Department of Aviation**. The prime contractor agrees further to return retainage payments to each subcontractor within **thirty (30) calendar** days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written approval of the **City of Manchester - Department of Aviation**. This clause applies to both DBE and non-DBE subcontractors.

Termination of DBE Subcontracts (49 CFR § 26.53(f)) –

The prime contractor must not terminate a DBE subcontractor listed in response to this Solicitation (or an approved substitute DBE firm) without prior written consent of the **City of Manchester - Department of Aviation**. This includes, but is not limited to, instances in which the prime contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm.

The prime contractor shall utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the Contractor obtains written consent of the **City of Manchester - Department of Aviation**. Unless the **City of Manchester - Department of Aviation** consent is provided, the prime contractor shall not be entitled to any payment for work or material unless it is performed or supplied by the listed DBE.

The **City of Manchester - Department of Aviation** may provide such written consent only if the **City of Manchester - Department of Aviation** agrees, for reasons stated in the concurrence document, that the

prime contractor has good cause to terminate the DBE firm. For purposes of this paragraph, good cause includes the circumstances listed in 49 CFR §26.53.

Before transmitting to the **City of Manchester - Department of Aviation** its request to terminate and/or substitute a DBE subcontractor, the prime contractor must give notice in writing to the DBE subcontractor, with a copy to the **City of Manchester - Department of Aviation**, of its intent to request to terminate and/or substitute, and the reason for the request.

The prime contractor must give the DBE five days to respond to the prime contractor's notice and advise the **City of Manchester - Department of Aviation** and the contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why the **City of Manchester - Department of Aviation** should not approve the prime contractor's action. If required in a particular case as a matter of public necessity (e.g., safety), the **City of Manchester - Department of Aviation** may provide a response period shorter than five days.

In addition to post-award terminations, the provisions of this section apply to pre-award deletions of or substitutions for DBE firms put forward by offerors in negotiated procurements.

DISTRACTED DRIVING
(Executive Order 13513, DOT Order 3902.10)

(Required for all FAA Airport Improvement Program funded contracts that exceed the micro-purchase threshold of 2 CFR § 200.320, currently set at $15,000)

TEXTING WHEN DRIVING

In accordance with Executive Order 13513, "Federal Leadership on Reducing Text Messaging While Driving", (10/1/2009) and DOT Order 3902.10, "Text Messaging While Driving", (12/30/2009), the Federal Aviation Administration encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or subgrant.

In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding $15,000 that involve driving a motor vehicle in performance of work activities associated with the project.

PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT
(2 CFR § 200, Appendix II(K); 2 CFR 200.216)
(Required for ALL contracts – regardless of funding)

PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT

Contractor and Subcontractor agree to comply with mandatory standards and policies relating to use and procurement of certain telecommunications and video surveillance services or equipment in compliance with the National Defense Authorization Act P.L. 115-232 § 889(f)(1).

FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)
(29 USC § 201, et seq; 2 CFR 200.430)
(Required for ALL contracts – regardless of funding)

SOLICITATION CLAUSE

All contracts and subcontracts that result from this solicitation incorporate by reference the provisions of 29 CFR Part 201, et seq, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers.

The ***Contractor*** has full responsibility to monitor compliance to the referenced statute or regulation. The ***Contractor*** must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

LOBBYING AND INFLUENCING FEDERAL EMPLOYEES
(31 USC § 1352 – Byrd Anti-Lobbying Amendment; 2 CFR part 200, Appendix II(i); 49 CFR part 20, Appendix A)

(Required for all FAA Airport Improvement Program funded contracts - $100,000 or Greater)

CERTIFICATION REGARDING LOBBYING

The Bidder or Offeror certifies by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by 31 U.S.C. § 1352. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

(29 CFR part 1910)

(Required for ALL contracts – regardless of funding)

CONTRACT CLAUSE

All contracts and subcontracts that result from this solicitation incorporate by reference the requirements of 29 CFR Part 1910 with the same force and effect as if given in full text. The employer must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The employer retains full responsibility to monitor its compliance and their subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (20 CFR Part 1910). The employer must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

PROCUREMENT OF RECOVERED MATERIALS
(2 CFR § 200.323; 2 CFR Part 200, Appendix II(J); 40 CFR part 247;
42 USC § 6901, et seq (Resource Conservation and Recovery Act (RCRA)))
(Required for all FAA Airport Improvement Program funded contracts exceeding $10,000)

PROCUREMENT OF RECOVERED MATERIALS

Contractor and subcontractor agree to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, and the regulatory provisions of 40 CFR Part 247. In the performance of this contract and to the extent practicable, the Contractor and subcontractors are to use products containing the highest percentage of recovered materials for items designated by the Environmental Protection Agency (EPA) under 40 CFR Part 247 whenever:

1) The contract requires procurement of $10,000 or more of a designated item during the fiscal year; or
2) The Contractor has procured $10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products.

Section 6002(c) establishes exceptions to the preference for recovery of EPA-designated products if the contractor can demonstrate the item is:

a) Not reasonably available within a timeframe providing for compliance with the contract performance schedule;
b) Fails to meet reasonable contract performance requirements; or
c) Is only available at an unreasonable price.

RIGHT TO INVENTIONS
(2 CFR Part 200, Appendix II(F); 37 CFR part 401)
(Limited for FAA Airport Improvement Program funded projects)

THIS SECTION IS NOT APPLICABLE FOR THIS CONTRACT.

RIGHTS TO INVENTIONS

Contracts or agreements that include the performance of experimental, developmental, or research work must provide for the rights of the Federal Government and the Owner in any resulting invention as established by 37 CFR part 401, Rights to Inventions Made by Non-profit Organizations and Small Business Firms under Government Grants, Contracts, and Cooperative Agreements. This contract incorporates by reference the patent and inventions rights as specified within 37 CFR § 401.14. Contractor must include this requirement in all sub-tier contracts involving experimental, developmental, or research work.

SEISMIC SAFETY
(49 CFR Part 41)
(Limited to FAA Airport Improvement Program funded)

(Applicable to construction of new buildings and additions to existing buildings)

THIS SECTION IS NOT APPLICABLE FOR THIS CONTRACT.

SEISMIC SAFETY

The Contractor agrees to ensure that all work performed under this contract, including work performed by subcontractors, conforms to a building code standard that provides a level of seismic safety substantially equivalent to standards established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety.

TAX DELINQUENCY AND FELONY CONVICTIONS
(Sections 8113 of the Consolidated Appropriations Act 2022 (P.L. 117-103) and similar provisions in subsequent appropriations acts; DOT Order 4200.6 – Appropriations Act Requirements for Procurement and Non-Procurement Regarding Tax Delinquency and Felony Convictions)

(Required for all FAA Airport Improvement Program funded contracts)

CERTIFICATION OF OFFEROR/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS

The applicant must complete the following two certification statements. The applicant must indicate its current status as it relates to tax delinquency and felony conviction by inserting a checkmark (✓) in the space following the applicable response. The applicant agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification in all lower tier subcontracts.

Certifications

1) The applicant represents that it is ( ) is not ( ) a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

2) The applicant represents that it is ( ) is not ( ) a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

Note

If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the Sponsor has received notification from the agency suspension and debarment official (SDO) that the SDO has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore must provide information to the owner about its tax liability or conviction to the Owner, who will then notify the FAA Airports District Office, which will then notify the agency's SDO to facilitate completion of the required considerations before award decisions are made.

Term Definitions

Felony conviction: Felony conviction means a conviction within the preceding twenty four (24) months of a felony criminal violation under any Federal law and includes conviction of an offense defined in a section of the U.S. Code that specifically classifies the offense as a felony and conviction of an offense that is classified as a felony under 18 USC § 3559.

Tax Delinquency: A tax delinquency is any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

TERMINATION OF CONTRACT

(2 CFR § 200 Appendix II(B); FAA Advisory Circular 150/5370-10 Sections 80-90)

(Required for all FAA Airport Improvement Program funded contracts in excess of $10,000)

TERMINATION FOR CONVENIENCE (CONSTRUCTION & EQUIPMENT CONTRACTS)

The Owner may terminate this contract in whole or in part at any time by providing written notice to the Contractor. Such action may be without cause and without prejudice to any other right or remedy of Owner. Upon receipt of a written notice of termination, except as explicitly directed by the Owner, the Contractor shall immediately proceed with the following obligations regardless of any delay in determining or adjusting amounts due under this clause:

1. Contractor must immediately discontinue work as specified in the written notice.
2. Terminate all subcontracts to the extent they relate to the work terminated under the notice.
3. Discontinue orders for materials and services except as directed by the written notice.
4. Deliver to the Owner all fabricated and partially fabricated parts, completed and partially completed work, supplies, equipment and materials acquired prior to termination of the work, and as directed in the written notice.
5. Complete performance of the work not terminated by the notice.
6. Take action as directed by the Owner to protect and preserve property and work related to this contract that Owner will take possession.

Owner agrees to pay Contractor for:

1) Completed and acceptable work executed in accordance with the contract documents prior to the effective date of termination;

2) Documented expenses sustained prior to the effective date of termination in performing work and furnishing labor, materials, or equipment as required by the contract documents in connection with uncompleted work;

3) Reasonable and substantiated claims, costs, and damages incurred in settlement of terminated contracts with Subcontractors and Suppliers; and

4) Reasonable and substantiated expenses to the Contractor directly attributable to Owner's termination action.

Owner will not pay Contractor for loss of anticipated profits or revenue or other economic loss arising out of or resulting from the Owner's termination action.

The rights and remedies this clause provides are in addition to any other rights and remedies provided by law or under this contract.

TERMINATION FOR CAUSE (CONSTRUCTION)

Section 80-09 of FAA Advisory Circular 150/5370-10 establishes standard language for conditions, rights, and remedies associated with Owner termination of this contract for cause due to default of the Contractor.

TERMINATION FOR CAUSE (EQUIPMENT)

The Owner may, by written notice of default to the Contractor, terminate all or part of this Contract if the Contractor:

1. Fails to begin the Work under the Contract within the time specified in the Notice- to-Proceed;
2. Fails to make adequate progress as to endanger performance of this Contract in accordance with its terms;
3. Fails to make delivery of the equipment within the time specified in the Contract, including any Owner approved extensions;
4. Fails to comply with material provisions of the Contract;
5. Submits certifications made under the Contract and as part of their proposal that include false or fraudulent statements; or
6. Becomes insolvent or declares bankruptcy.

If one or more of the stated events occur, the Owner will give notice in writing to the Contractor and Surety of its intent to terminate the contract for cause. At the Owner's discretion, the notice may allow the Contractor and Surety an opportunity to cure the breach or default.

If within 10 days of the receipt of notice, the Contractor or Surety fails to remedy the breach or default to the satisfaction of the Owner, the Owner has authority to acquire equipment by other procurement action. The Contractor will be liable to the Owner for any excess costs the Owner incurs for acquiring such similar equipment.

Payment for completed equipment delivered to and accepted by the Owner shall be at the Contract price. The Owner may withhold from amounts otherwise due the Contractor for such completed equipment, such sum as the Owner determines to be necessary to protect the Owner against loss because of Contractor default.

Owner will not terminate the Contractor's right to proceed with the work under this clause if the delay in completing the work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such acceptable causes include: acts of God, acts of the Owner, acts of another Contractor in the performance of a contract with the Owner, and severe weather events that substantially exceed normal conditions for the location.

If, after termination of the Contractor's right to proceed, the Owner determines that the Contractor was not in default, or that the delay was excusable, the rights and obligations of the parties will be the same as if the Owner issued the termination for the convenience the Owner.

The rights and remedies of the Owner in this clause are in addition to any other rights and remedies provided by law or under this contract.

TRADE RESTRICTION CERTIFICATION
(49 USC § 50104; 49 CFR part 30)
(Required for all FAA Airport Improvement Program funded projects)

TRADE RESTRICTION CERTIFICATION

By submission of an offer, the Offeror certifies that with respect to this solicitation and any resultant contract, the Offeror –

1) is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms as published by the Office of the United States Trade Representative (USTR);

2) has not knowingly entered into any contract or subcontract for this project with a person that is a citizen or national of a foreign country included on the list of countries that discriminate against U.S. firms as published by the USTR; and

3) has not entered into any subcontract for any product to be used on the Federal project that is produced in a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR.

This certification concerns a matter within the jurisdiction of an agency of the United States of America and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18 USC Section 1001.

The Offeror/Contractor must provide immediate written notice to the Owner if the Offeror/Contractor learns that its certification or that of a subcontractor was erroneous when submitted or has become erroneous by reason of changed circumstances. The Contractor must require subcontractors provide immediate written notice to the Contractor if at any time it learns that its certification was erroneous by reason of changed circumstances.

Unless the restrictions of this clause are waived by the Secretary of Transportation in accordance with 49 CFR § 30.17, no contract shall be awarded to an Offeror or subcontractor:

1) who is owned or controlled by one or more citizens or nationals of a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR; or
2) whose subcontractors are owned or controlled by one or more citizens or nationals of a foreign country on such USTR list; or
3) who incorporates in the public works project any product of a foreign country on such USTR list.

Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by this provision. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

The Offeror agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification without modification in all lower tier subcontracts. The Contractor may rely on the certification of a prospective subcontractor that it is not a firm from a foreign country included on the list of countries that discriminate against U.S. firms as published by USTR, unless the Offeror has knowledge that the certification is erroneous.

This certification is a material representation of fact upon which reliance was placed when making an award. If it is later determined that the Contractor or subcontractor knowingly rendered an erroneous certification, the Federal Aviation Administration (FAA) may direct through the Owner cancellation of the contract or subcontract for default at no cost to the Owner or the FAA.

VETERAN'S PREFERENCE
(49 USC § 47112(c))
(Required for all FAA Airport Improvement Program funded projects)

VETERAN'S PREFERENCE

In the employment of labor (excluding executive, administrative, and supervisory positions), the Contractor and all sub-tier contractors must give preference to covered veterans as defined within 49 U.S.C. § 47112. Covered veterans include Vietnam-era veterans, Persian Gulf veterans, Afghanistan-Iraq war veterans, disabled veterans, and small business concerns (as defined by 15 U.S.C. § 632) owned and controlled by disabled veterans. This preference only applies when there are covered veterans readily available and qualified to perform the work to which the employment relates.

DOMESTIC PREFERENCE FOR PROCUREMENTS
(2 CFR § 200.322; 2 CFR Part 200, Appendix II(L))
(Required for all FAA Airport Improvement Program funded contracts)

CERTIFICATION REGARDING DOMESTIC PREFERENCES FOR PROCUREMENTS

The Bidder or Offeror certifies by signing and submitting this bid or proposal that, to the greatest extent practicable, the Bidder or Offeror has provided a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States (including, but not limited to, iron, aluminum, steel, cement, and other manufactured products) in compliance with 2 CFR § 200.322.

PROHIBITION OF COVERED UNMANNED AIRCRAFT SYSTEMS (UAS)
(FAA Reauthorization Act of 2024 (Public Law 118-3), Section 936; 49 U.S.C. § 44801 note)
(Required for all FAA Airport Improvement Program funded contracts)

CONTRACT CLAUSE

The Bidder or Offeror certifies that they are aware of and comply with relevant Federal statutes and regulations, including those from the Federal Aviation Administration (FAA), for operating unmanned aircraft systems (UAS) in accordance, and in compliance with all related requirements in the FAA Reauthorization Act of 2024 (Public Law 118-63), section 936 (49 U.S.C. § 44801 note).

Contractor warrants that all UAS operations will be conducted in full compliance with all applicable Federal Aviation Administration (FAA) regulations, including but not limited to 14 CFR Part 107, and any other applicable local, state, or Federal laws and regulations.

Sponsors and subgrant recipients cannot use AIP grant funds to enter into, extend, or renew a contract related to covered unmanned aircraft systems (UAS). This includes both procurement and operational contracts, as well as contracts with entities that operate such systems.

CONTRACT REFERENCE DOCUMENTS

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This content is from the eCFR and is authoritative but unofficial.

Title 49 —Transportation
Subtitle A —Office of the Secretary of Transportation

Part 26 Participation by Disadvantaged Business Enterprises in Department of Transportation Financial Assistance Programs
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  - **§ 26.3** To whom does this part apply?
  - **§ 26.5** Definitions.
  - **§ 26.7** What discriminatory actions are forbidden?
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  - **§ 26.11** What records do recipients keep and report?
  - **§ 26.13** What assurances must recipients and contractors make?
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PART 26—PARTICIPATION BY DISADVANTAGED BUSINESS ENTERPRISES IN DEPARTMENT OF TRANSPORTATION FINANCIAL ASSISTANCE PROGRAMS

Authority: 23 U.S.C. 304 and 324; 42 U.S.C. 2000d, *et seq.;* 49 U.S.C. 47113, 47123; Sec. 1101(b), Pub. L. 114-94, 129 Stat. 1312, 1324 (23 U.S.C. 101 note); Sec. 150, Pub. L. 115-254, 132 Stat. 3215 (23 U.S.C. 101 note); Pub. L. 117-58, 135 Stat. 429 (23 U.S.C. 101 note).

Source: 64 FR 5126, Feb. 2, 1999, unless otherwise noted.

Subpart A—General

§ 26.1 What are the objectives of this part?

This part seeks to achieve several objectives:

(a) To ensure nondiscrimination in the award and administration of DOT-assisted contracts in the Department's highway, transit, and airport financial assistance programs;

(b) To create a level playing field on which DBEs can compete fairly for DOT-assisted contracts;

(c) To ensure that the Department's DBE program operates in a nondiscriminatory manner and without regard to race or sex, while maximizing efficiency of service;

(d) To ensure that only firms that fully meet this part's eligibility standards are permitted to participate as DBEs;

(e) To help remove barriers to the participation of DBEs in DOT-assisted contracts;

(f) To promote the use of DBEs in all types of federally assisted contracts and procurement activities conducted by recipients.

(g) To assist the development of firms that can compete successfully in the marketplace outside the DBE program; and

(h) To provide appropriate flexibility to recipients of Federal financial assistance in establishing and providing opportunities for DBEs.

[64 FR 5126, Feb. 2, 1999, as amended at 79 FR 59592, Oct. 2, 2014; 89 FR 24963, Apr. 9, 2024; 90 FR 47979, Oct. 3, 2025]

§ 26.3 To whom does this part apply?

(a) If you are a recipient of any of the following types of funds, this part applies to you:

(1) Federal-aid highway funds authorized under Titles I (other than Part B) and V of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), Public Law 102-240, 105 Stat. 1914, or Titles I, III, and V of the Transportation Equity Act for the 21st Century (TEA-21), Public Law 105-178, 112 Stat. 107. Titles I, III, and V of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Public Law 109-59, 119 Stat. 1144; Divisions A and B of the Moving Ahead for Progress in the 21st Century Act (MAP-21), Pub. L. 112-141, 126 Stat. 405; Titles I, II, III,

and VI of the Fixing America's Surface Transportation Act (FAST Act) Public Law 114-94;, and Divisions A and C of the Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act (IIJA), Public Law 117-58.

(2) Federal transit funds authorized by Titles I, III, V and VI of ISTEA, Public Law 102-240 or by Federal transit laws in Title 49, U.S. Code, or Titles I, III, and V of the TEA-21, Public Law 105-178. Titles I, III, and V of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Public Law 109-59, 119 Stat. 1144; Divisions A and B of the Moving Ahead for Progress in the 21st Century Act (MAP-21), Public Law 112-141, 126 Stat. 405; Titles I, II, III, and VI of the Fixing America's Surface Transportation Act (FAST Act) Public Law 114-94; and Divisions A and C of the Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. 117-58), Public Law 117-58.

(3) Airport funds authorized by 49 U.S.C. 47101, *et seq.*

(b) [Reserved]

(c) If you are letting a contract, and that contract is to be performed entirely outside the United States, its territories and possessions, Puerto Rico, Guam, or the Northern Mariana Islands, this part does not apply to the contract.

(d) If you are letting a contract in which DOT financial assistance does not participate, this part does not apply to the contract.

[89 FR 24963, Apr. 9, 2024]

§ 26.5 Definitions.

Affiliation has the same meaning the term has in the Small Business Administration (SBA) regulations, 13 CFR part 121.

(1) Except as otherwise provided in 13 CFR part 121, concerns are affiliates of each other when, either directly or indirectly:

(i) One concern controls or has the power to control the other; or

(ii) A third party or parties controls or has the power to control both; or

(iii) An identity of interest between or among parties exists such that affiliation may be found.

(2) In determining whether affiliation exists, it is necessary to consider all appropriate factors, including common ownership, common management, and contractual relationships. Affiliates must be considered together in determining whether a concern meets small business size criteria and the statutory cap on the participation of firms in the DBE program.

Alaska Native means a citizen of the United States who is a person of one-fourth degree or more Alaskan Indian (including Tsimshian Indians not enrolled in the Metlakatla Indian Community), Eskimo, or Aleut blood, or a combination of those bloodlines. The term includes, in the absence of proof of a minimum blood quantum, any citizen whom a Native village or Native group regards as an Alaska Native if their father or mother is regarded as an Alaska Native.

Alaska Native Corporation (ANC) means any Regional Corporation, Village Corporation, Urban Corporation, or Group Corporation organized under the laws of the State of Alaska in accordance with the Alaska Native Claims Settlement Act, as amended (43 U.S.C. 1601, *et seq.*).

Assets mean all the property of a person available for paying debts or for distribution, including one's respective share of jointly held assets. This includes, but is not limited to, cash on hand and in banks, savings accounts, IRA or other retirement accounts, accounts receivable, life insurance, stocks and bonds, real estate, and personal property.

Business, business concern or business enterprise means an entity organized for profit with a place of business located in the United States, and which operates primarily within the United States or which makes a significant contribution to the United States economy through payment of taxes or use of American products, materials, or labor.

Compliance means that a recipient has correctly implemented the requirements of this part.

Contingent Liability means a liability that depends on the occurrence of a future and uncertain event. This includes, but is not limited to, guaranty for debts owed by the applicant concern, legal claims and judgments, and provisions for federal income tax.

Contract means a legally binding relationship obligating a seller to furnish supplies or services (including, but not limited to, construction and professional services) and the buyer to pay for them. For purposes of this part, a lease is considered to be a contract.

Contractor means one who participates, through a contract or subcontract (at any tier), in a DOT-assisted highway, transit, or airport program.

Days mean calendar days. In computing any period of time described in this part, the day from which the period begins to run is not counted, and when the last day of the period is a Saturday, Sunday, or Federal holiday, the period extends to the next day that is not a Saturday, Sunday, or Federal holiday. Similarly, in circumstances where the recipient's offices are closed for all or part of the last day, the period extends to the next day on which the agency is open.

DBE-conscious measure or program is one that is focused specifically on assisting only DBEs.

DBE-neutral measure or program is one that is, or can be, used to assist all small businesses.

Department or *DOT* means the U.S. Department of Transportation, including the Office of the Secretary, the Departmental Office of Civil Rights, the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the Federal Aviation Administration (FAA).

Disadvantaged Business Enterprise or *DBE* means a for-profit small business concern—

(1) That is at least 51 percent owned by one or more individuals who are both socially and economically disadvantaged; and

(2) Whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

DOT-assisted contract means any contract between a recipient and a contractor (at any tier) funded in whole or in part with DOT financial assistance, including letters of credit or loan guarantees, except a contract solely for the purchase of land.

FTA Tier I recipient means an FTA recipient to whom this part applies that will award prime contracts (excluding transit vehicle purchases) the cumulative total value of which exceeds $670,000 in FTA funds in a Federal fiscal year.

FTA Tier II recipient means an FTA recipient to whom this part applies who will award prime contracts (excluding transit vehicle purchases) the cumulative total value of which does not exceed $670,000 in FTA funds in a Federal fiscal year.

Good faith efforts means efforts to achieve a DBE goal or other requirement of this part which, by their scope, intensity, and appropriateness to the objective, can reasonably be expected to fulfill the program requirement.

Immediate family member means father, mother, husband, wife, son, daughter, brother, sister, grandfather, grandmother, father-in-law, mother-in-law, sister-in-law, brother-in-law, and domestic partner and civil unions recognized under State law.

Indian Tribe or *Native American Tribe* means any federally or State-recognized Tribe, band, nation, or other organized group of Indians (Native Americans), or an ANC.

Joint venture means an association of a DBE firm and one or more other firms to carry out a single, for-profit business enterprise, for which the parties combine their property, capital, efforts, skills and knowledge, and in which the DBE is responsible for a distinct, clearly defined portion of the work of the contract and whose share in the capital contribution, control, management, risks, and profits of the joint venture are commensurate with its ownership interest.

Liabilities mean financial or pecuniary obligations. This includes, but is not limited to, accounts payable, notes payable to bank or others, installment accounts, mortgages on real estate, and unpaid taxes.

Native Hawaiian means any individual whose ancestors were natives, prior to 1778, of the area which now comprises the State of Hawaii.

Native Hawaiian Organization means any community service organization serving Native Hawaiians in the State of Hawaii which is a not-for-profit organization chartered by the State of Hawaii, is controlled by Native Hawaiians, and whose business activities will principally benefit such Native Hawaiians.

Noncompliance means that a recipient has not correctly implemented the requirements of this part.

Notice of decision or *NOD* means determination that denies a firm's application or decertifies a DBE.

Notice of intent or *NOI* means recipients letter informing a DBE of a suspension or proposed decertification.

Operating Administration or *OA* means any of the following parts of DOT: the Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), and Federal Transit Administration (FTA). The "Administrator" of an operating administration includes his or her designees.

Personal net worth or *PNW* means the net value of an individual's reportable assets and liabilities, per the calculation rules in § 26.68.

Primary industry classification means the most current North American Industry Classification System (NAICS) designation which best describes the primary business of a firm. The NAICS is described in the North American Industry Classification Manual—United States, which is available online on the U.S. Census Bureau website: *www.census.gov/naics/*.

Primary recipient means a recipient which receives DOT financial assistance and passes some or all of it on to another recipient.

Principal place of business means the business location where the individuals who manage the firm's day-to-day operations spend most working hours. If the offices from which management is directed and where the business records are kept are in different locations, the recipient will determine the principal place of business. The term does not include construction trailers or other temporary construction sites.

Program means any undertaking on a recipient's part to use DOT financial assistance, authorized by the laws to which this part applies.

Recipient means any entity, public or private, to which DOT financial assistance is extended, whether directly or through another recipient, through the programs of the FAA, FHWA, or FTA, or that has applied for such assistance.

Secretary means DOT's Secretary of Transportation or the Secretary's designee.

Set-aside means a contracting practice restricting eligibility for the competitive award of a contract solely to DBE firms.

Small Business Administration or *SBA* means the United States Small Business Administration.

SBA certified firm refers to firms that have a current, valid certification from or recognized by the SBA under the 8(a) BD or SDB programs.

Small business concern means, with respect to firms seeking to participate as DBEs in DOT-assisted contracts, a small business concern as defined pursuant to section 3 of the Small Business Act and Small Business Administration regulations implementing it (13 CFR part 121) that also does not exceed the cap on average annual gross receipts specified in § 26.65(b).

Socially and economically disadvantaged individual means any individual who is a citizen (or lawfully admitted permanent resident) of the United States and who a certifier finds to be socially and economically disadvantaged on a case-by-case basis. A determination that an individual is socially and economically disadvantaged must not be based in whole or in part on race or sex. For that reason, all applicants shall qualify as socially and economically disadvantaged if they can meet the relevant criteria described in § 26.67. Being born in a particular country does not, standing alone, mean that a person is necessarily socially and economically disadvantaged.

Spouse means a married person, including a person in a domestic partnership or a civil union recognized under State law.

Transit vehicle manufacturer (TVM) means any manufacturer whose primary business purpose is to manufacture vehicles built for mass transportation. Such vehicles include, but are not limited to buses, rail cars, trolleys, ferries, and vehicles manufactured specifically for paratransit purposes. Businesses that perform retrofitting or post-production alterations to vehicles so that such vehicles may be used for public transportation purposes are also considered TVMs. Businesses that manufacture, mass-produce, or distribute vehicles primarily for personal use are not considered TVMs.

Tribally-owned concern means any concern at least 51 percent owned by an Indian tribe as defined in this section.

Unsworn declaration means an unsworn statement, dated and in writing, subscribed as true under penalty of perjury.

You refers to a recipient, unless a statement in the text of this part or the context requires otherwise (i.e., 'You must do XYZ' means that recipients must do XYZ).

[64 FR 5126, Feb. 2, 1999, as amended at 64 FR 34570, June 28, 1999; 68 FR 35553, June 16, 2003; 76 FR 5096, Jan. 28, 2011; 79 FR 59592, Oct. 2, 2014; 89 FR 24963, Apr. 9, 2024; 90 FR 47979, Oct. 3, 2025]

§ 26.7 What discriminatory actions are forbidden?

(a) You must never exclude any person from participation in, deny any person the benefits of, or otherwise discriminate against anyone in connection with the award and performance of any contract covered by this part on the basis of race, color, sex, or national origin.

(b) In administering your DBE program, you must not, directly or through contractual or other arrangements, use criteria or methods of administration that have the effect of defeating or substantially impairing accomplishment of the objectives of the program with respect to individuals of a particular race, color, sex, or national origin.

§ 26.9 How does the Department issue guidance and interpretations under this part?

(a) Only guidance and interpretations (including interpretations set forth in certification appeal decisions) consistent with this part 26 and issued after March 4, 1999 express the official positions and views of the Department of Transportation or any of its operating administrations.

(b) The Secretary of Transportation, Office of the Secretary of Transportation, FHWA, FTA, and FAA may issue written interpretations of or written guidance concerning this part. Written interpretations and guidance are valid, and express the official positions and views of the Department of Transportation or any of its operating administrations, only if they are issued over the signature of the Secretary of Transportation or if they contain the following statement:

> The General Counsel of the Department of Transportation has reviewed this document and approved it as consistent with the language and intent of 49 CFR part 26.

[72 FR 15617, Apr. 2, 2007]

§ 26.11 What records do recipients keep and report?

(a) You must submit a report on DBE participation to the concerned Operating Administration containing all the information described in the Uniform Report to this part. This report must be submitted at the intervals required by, and in the format acceptable to, the concerned Operating Administration.

(b) You must continue to provide data about your DBE program to the Department as directed by DOT Operating Administrations.

(c) You must obtain bidders list information as described in paragraph (c)(2) of this section and enter it into a system designated by the Department.

(1) The purpose of this bidders list information is to compile as accurate data as possible about the universe of DBE and non-DBE contractors and subcontractors who seek to work on your federally assisted contracts for use in helping you set your overall goals, and to provide the Department with data for evaluating the extent to which the objectives of § 26.1 are being achieved.

(2) You must obtain the following bidders list information about all DBE and non-DBEs who bid as prime contractors and subcontractors on each of your federally assisted contracts:

(i) Firm name;

(ii) Firm address including ZIP code;

(iii) Firm's status as a DBE or non-DBE;

(iv) NAICS code applicable to each scope of work the firm sought to perform in its bid;

(v) Age of the firm; and

(vi) The annual gross receipts of the firm. You may obtain this information by asking each firm to indicate into what gross receipts bracket they fit (*e.g.,* less than $1 million; $1-3 million; $3-6 million; $6-10 million; etc.) rather than requesting an exact figure from the firm.

(3) You must collect the data from all bidders for your federally assisted contracts by requiring the information in paragraph (c)(2) of this section to be submitted with their bids or initial responses to negotiated procurements. You must enter this data in the Department's designated system no later than December 1 following the fiscal year in which the relevant contract was awarded. In the case of a "design-build" contracting situation where subcontracts will be solicited throughout the contract period as defined in a DBE Performance Plan pursuant to § 26.53(e), the data must be entered no later than December 1 following the fiscal year in which the design-build contractor awards the relevant subcontract(s).

(d) You must maintain records documenting a firm's compliance with the requirements of this part. At a minimum, you must keep a complete application package for each certified firm and all Declarations of Eligibility, change notices, and on-site visit reports. These records must be retained in accordance with applicable record retention requirements for the recipient's financial assistance agreement. Other certification or compliance related records must be retained for a minimum of three (3) years unless otherwise provided by applicable record retention requirements for the recipient's financial assistance agreement, whichever is longer.

(e) The State department of transportation in each Unified Certification Program (UCP) established pursuant to § 26.81 must report to DOT's Departmental Office of Civil Rights each year, the following information:

(1) The number of DBE certification applications received from in-state and out-of-state firms and the number found eligible and ineligible;

(2) The number of decertified firms:

(i) Total in-state and out-of-state firms decertified;

(ii) Names of in-state and out-of-state firms decertified because SEDO exceeded the personal net worth cap;

(iii) Names of in-state and out-of-state firms decertified for excess gross receipts beyond the relevant size standard.

(3) The number of in-state and out-of-state firms summarily suspended;

[89 FR 24964, Apr. 9, 2024, as amended at 90 FR 47979, Oct. 3, 2025]

§ 26.13 What assurances must recipients and contractors make?

(a) Each financial assistance agreement you sign with a DOT operating administration (or a primary recipient) must include the following assurance: The recipient shall not discriminate on the basis of race, color, national origin, or sex in the award and performance of any DOT-assisted contract or in the administration of its DBE program or the requirements 49 CFR part 26. The recipient shall take all necessary and reasonable steps under 49 CFR part 26 to ensure nondiscrimination in the award and administration of

DOT-assisted contracts. The recipient's DBE program, as required by 49 CFR part 26 and as approved by DOT, is incorporated by reference in this agreement. Implementation of this program is a legal obligation and failure to carry out its terms shall be treated as a violation of this agreement. Upon notification to the recipient of its failure to carry out its approved program, the Department may impose sanctions as provided for under 49 CFR part 26 and may, in appropriate cases, refer the matter for enforcement under 18 U.S.C. 1001 and/or the Program Fraud Civil Remedies Act of 1986 (31 U.S.C. 3801 et seq.).

(b) Each contract you sign with a contractor (and each subcontract the prime contractor signs with a subcontractor) must include the following assurance: The contractor, sub recipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:

(1) Withholding monthly progress payments;

(2) Assessing sanctions;

(3) Liquidated damages; and/or

(4) Disqualifying the contractor from future bidding as non-responsible.

[79 FR 59593, Oct. 2, 2014]

§ 26.15 How can recipients apply for exemptions or waivers?

(a) You can apply for an exemption from any provision of this part. To apply, you must request the exemption in writing from the Office of the Secretary of Transportation, FHWA, FTA, or FAA. The Secretary will grant the request only if it documents special or exceptional circumstances, not likely to be generally applicable, and not contemplated in connection with the rulemaking that established this part, that make your compliance with a specific provision of this part impractical. You must agree to take any steps that the Department specifies to comply with the intent of the provision from which an exemption is granted. The Secretary will issue a written response to all exemption requests.

(b) You can apply for a waiver of any provision of Subpart B or C of this part including, but not limited to, any provisions regarding administrative requirements, overall goals, contract goals or good faith efforts. Program waivers are for the purpose of authorizing you to operate a DBE program that achieves the objectives of this part by means that may differ from one or more of the requirements of Subpart B or C of this part. To receive a program waiver, you must follow these procedures:

(1) You must apply through the concerned operating administration. The application must include a specific program proposal and address how you will meet the criteria of paragraph (b)(2) of this section. Before submitting your application, you must have had public participation in developing your proposal, including consultation with the DBE community and at least one public hearing. Your application must include a summary of the public participation process and the information gathered through it.

(2) Your application must show that—

(i) There is a reasonable basis to conclude that you could achieve a level of DBE participation consistent with the objectives of this part using different or innovative means other than those that are provided in subpart B or C of this part;

(ii) Conditions in your jurisdiction are appropriate for implementing the proposal;

(iii) Your proposal would prevent discrimination against any individual or group in access to contracting opportunities or other benefits of the program; and

(iv) Your proposal is consistent with applicable law and program requirements of the concerned operating administration's financial assistance program.

(3) The Secretary has the authority to approve your application. If the Secretary grants your application, you may administer your DBE program as provided in your proposal, subject to the following conditions:

(i) DBE eligibility is determined as provided in subparts D and E of this part, and DBE participation is counted as provided in § 26.49;

(ii) Your level of DBE participation continues to be consistent with the objectives of this part;

(iii) There is a reasonable limitation on the duration of your modified program; and

(iv) Any other conditions the Secretary makes on the grant of the waiver.

(4) The Secretary may end a program waiver at any time and require you to comply with this part's provisions. The Secretary may also extend the waiver, if he or she determines that all requirements of paragraphs (b)(2) and (3) of this section continue to be met. Any such extension shall be for no longer than period originally set for the duration of the program.

Subpart B—Administrative Requirements for DBE Programs for Federally Assisted Contracting

§ 26.21 Who must have a DBE program?

(a) If you are in one of these categories and let DOT-assisted contracts, you must have a DBE program meeting the requirements of this part:

(1) All FHWA primary recipients receiving funds authorized by a statute to which this part applies;

(2) All FTA recipients receiving planning, capital and/or operating assistance must maintain a DBE program.

(i) FTA Tier I recipients must have a DBE program meeting all the requirements of this part.

(ii) Beginning 180 days after the publication of the final rule, FTA Tier II recipients must maintain a program locally meeting the following requirements of this part:

(A) Reporting and recordkeeping under § 26.11;

(B) Contract assurances under § 26.13;

(C) Policy statement under § 26.23;

(D) Fostering small business participation under § 26.39; and

(E) Transit vehicle procurements under § 26.49.

(3) FAA recipients receiving grants for airport planning or development that will award prime contracts the cumulative total value of which exceeds $250,000 in FAA funds in a Federal fiscal year.

(b)

(1) You must submit a conforming DBE program to the concerned Operating Administration (OA). Once the OA has approved your program, the approval counts for all of your DOT-assisted programs (except goals that are reviewed by the relevant OA).

(2) You do not have to submit regular updates of your DBE program plan if you remain in compliance with this part. However, you must submit significant changes to the relevant OA for approval.

(c) You are not eligible to receive DOT financial assistance unless DOT has approved your DBE program and you are in compliance with it and this part. You must continue to carry out your DBE program until all funds from DOT financial assistance have been expended.

[89 FR 24965, Apr. 9, 2024]

§ 26.23 What is the requirement for a policy statement?

You must issue a signed and dated policy statement that expresses your commitment to your DBE program, states its objectives, and outlines responsibilities for its implementation. You must circulate the statement throughout your organization and to the DBE and non-DBE business communities that perform work on your DOT-assisted contracts.

§ 26.25 What is the requirement for a liaison officer?

You must have a DBE liaison officer, who shall have direct, independent access to your Chief Executive Officer concerning DBE program matters. The liaison officer shall be responsible for implementing all aspects of your DBE program. You must also have adequate staff to administer the program in compliance with this part.

§ 26.27 What efforts must recipients make concerning DBE financial institutions?

You must thoroughly investigate the full extent of services offered by financial institutions owned and controlled by socially and economically disadvantaged individuals in your community and make reasonable efforts to use these institutions. You must also encourage prime contractors to use such institutions.

§ 26.29 What prompt payment mechanisms must recipients have?

(a) You must establish, as part of your DBE program, a contract clause to require prime contractors to pay subcontractors for satisfactory performance of their contracts no later than 30 days from receipt of each payment you make to the prime contractor.

(b) You must ensure prompt and full payment of retainage from the prime contractor to the subcontractor within 30 days after the subcontractor's work is satisfactorily completed. You must use one of the following methods to comply with this requirement:

(1) You may decline to hold retainage from prime contractors and prohibit prime contractors from holding retainage from subcontractors.

(2) You may decline to hold retainage from prime contractors and require a contract clause obligating prime contractors to make prompt and full payment of any retainage kept by prime contractor to the subcontractor within 30 days after the subcontractor's work is satisfactorily completed.

(3) You may hold retainage from prime contractors and provide for prompt and regular incremental acceptances of portions of the prime contract, pay retainage to prime contractors based on these acceptances, and require a contract clause obligating the prime contractor to pay all retainage owed to the subcontractor for satisfactory completion of the accepted work within 30 days after your payment to the prime contractor.

(c) For purposes of this section, a subcontractor's work is satisfactorily completed when all the tasks called for in the subcontract have been accomplished and documented as required by the recipient. When a recipient has made an incremental acceptance of a portion of a prime contract, the work of a subcontractor covered by that acceptance is deemed to be satisfactorily completed.

(d) Your DBE program must include the mechanisms you will use for proactive monitoring and oversight of a prime contractor's compliance with subcontractor prompt payment and return of retainage requirements in this part. Reliance on complaints or notifications from subcontractors about a contractor's failure to comply with prompt payment and retainage requirements is not a sufficient monitoring and oversight mechanism.

(e) Your DBE program must provide appropriate means to enforce the requirements of this section. These means must be described in your DBE program and should include appropriate penalties for failure to comply, the terms and conditions of which you set. Your program may also provide that any delay or postponement of payment among the parties may take place only for good cause, with your prior written approval.

(f) Prompt payment and return of retainage requirements in this part also apply to all lower-tier subcontractors.

(g) You may also establish, as part of your DBE program, any of the following additional mechanisms to ensure prompt payment:

(1) A contract clause that requires prime contractors to include in their subcontracts language providing that prime contractors and subcontractors will use appropriate alternative dispute resolution mechanisms to resolve payment disputes. You may specify the nature of such mechanisms.

(2) A contract clause providing that the prime contractor will not be reimbursed for work performed by subcontractors unless and until the prime contractor ensures that the subcontractors are promptly paid for the work they have performed.

(3) Other mechanisms, consistent with this part and applicable state and local law, to ensure that DBEs and other contractors are fully and promptly paid.

[68 FR 35553, June 16, 2003, as amended at 89 FR 24965, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.31 What information must a UCP include in its DBE/ACDBE directory?

(a) In the directory required under § 26.81(g), you must list all firms eligible to participate as a DBE and/or ACDBE in your program. In the listing for each firm, you must include its business address, business phone number, firm website(s), and the types of work the firm has been certified to perform as a DBE and/or ACDBE.

(b) You must list each type of work a DBE and/or ACDBE is eligible to perform by using the most specific NAICS code available to describe each type of work the firm performs. Pursuant to § 26.73(a), your directory must allow for NAICS codes to be supplemented with specific descriptions of the type(s) of work the firm performs.

(c) Your directory may include additional data fields of other items readily verifiable in State or locally maintained databases, such as State licenses held, Prequalifications, and Bonding capacity.

(d) Your directory must be an online system that permits the public to search and/or filter for DBEs by:

(1) Physical location;

(2) NAICS code(s);

(3) Work descriptions; and

(4) All optional information added pursuant to paragraph (c) of this section. The directory must include a prominently displayed disclaimer (*e.g.,* large type, bold font) that states the information within the directory is not a guarantee of the DBE's capacity and ability to perform work.

(e) You must make any changes to your current directory entries by November 5, 2024.

[89 FR 24965, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.33 What steps must a recipient take to address overconcentration of DBEs in certain types of work?

(a) If you determine that DBE firms are so overconcentrated in a certain type of work as to unduly burden the opportunity of non-DBE firms to participate in this type of work, you must devise appropriate measures to address this overconcentration.

(b) These measures may include the use of incentives, technical assistance, business development programs, mentor-protégé programs, and other appropriate measures designed to assist DBEs in performing work outside of the specific field in which you have determined that non-DBEs are unduly burdened. You may also consider varying your use of contract goals, to the extent consistent with § 26.51, to unsure that non-DBEs are not unfairly prevented from competing for subcontracts.

(c) You must obtain the approval of the concerned DOT operating administration for your determination of overconcentration and the measures you devise to address it. Once approved, the measures become part of your DBE program.

§ 26.35 What role do business development and mentor-protégé programs have in the DBE program?

(a) You may or, if an operating administration directs you to, you must establish a DBE business development program (BDP) to assist firms in gaining the ability to compete successfully in the marketplace outside the DBE program. You may require a DBE firm, as a condition of receiving assistance through the BDP, to agree to terminate its participation in the DBE program after a certain time has passed or certain objectives have been reached. See Appendix C of this part for guidance on administering BDP programs.

(b) As part of a BDP or separately, you may establish a “mentor-protégé” program, in which another DBE or non-DBE firm is the principal source of business development assistance to a DBE firm.

(1) Only firms you have certified as DBEs before they are proposed for participation in a mentor-protégé program are eligible to participate in the mentor-protégé program.

(2) In the mentor-protégé relationship, you must:

(i) Not award DBE credit to a non-DBE mentor firm for using its own protégé firm for more than one half of its goal on any contract let by the recipient; and

(ii) Not award DBE credit to a non-DBE mentor firm for using its own protégé firm for more than every other contract performed by the protégé firm.

(3) For purposes of making determinations of business size under this part, you must not treat protégé firms as affiliates of mentor firms, when both firms are participating under an approved mentor-protégé program. See Appendix D of this part for guidance concerning the operation of mentor-protégé programs.

(c) Your BDPs and mentor-protégé programs must be approved by the concerned operating administration before you implement them. Once approved, they become part of your DBE program.

[64 FR 5126, Feb. 2, 1999, as amended at 89 FR 24966, Apr. 9, 2024]

§ 26.37 What are a recipient's responsibilities for monitoring?

(a) A recipient must implement appropriate mechanisms to ensure compliance with the requirements in this part by all program participants (*e.g.,* applying legal and contract remedies available under Federal, State, and local law). The recipient must set forth these mechanisms in its DBE program.

(b) A recipient's DBE program must also include a monitoring and enforcement mechanism to ensure that work committed, or in the case of DBE-neutral participation, the work subcontracted, to all DBEs at contract award or subsequently is performed by the DBEs to which the work was committed or subcontracted to, and such work is counted according to the requirements of § 26.55. This mechanism must include a written verification that you have reviewed contracting records and monitored the work site to ensure the counting of each DBE's participation is consistent with its function on the contract. The monitoring to which this paragraph (b) refers may be conducted in conjunction with monitoring of contract performance for other purposes such as a commercially useful function review.

(c) You must effectively implement the following running tally mechanisms:

(1) With respect to achieving your overall goal, you must use a running tally that provides for a frequent comparison of cumulative DBE awards/commitments to DOT-assisted prime contract awards to determine whether your current implementation of contract goals is projected to be sufficient to meet your annual goal. This mechanism should inform your decisions to implement goals on contracts to be advertised according to your established contract goal-setting process.

(2) With respect to each DBE commitment, you must use a running tally that provides for a frequent comparison of payments made to each listed DBE relative to the progress of work, including payments for such work to the prime contractor to determine whether the contractor is on track with meeting its DBE commitment and whether any projected shortfall exists that requires the prime contractor's good faith efforts to address to meet the contract goal pursuant to § 26.53(g).

[89 FR 24966, Apr. 9, 2024, as amended at 90 FR 47979, Oct. 3, 2025]

§ 26.39 Fostering small business participation.

(a) Your DBE program must include an element to structure contracting requirements to facilitate competition by small business concerns, taking all reasonable steps to eliminate obstacles to their participation, including unnecessary and unjustified bundling of contract requirements that may preclude small business participation in procurements as prime contractors or subcontractors.

(b) This element must be submitted to the appropriate DOT operating administration for approval as a part of your DBE program. As part of this program element you may include, but are not limited to, the following strategies:

(1) Establishing a DBE-neutral small business set-aside for prime contracts under a stated amount (*e.g.,* $1 million).

(2) In multi-year design-build contracts or other large contracts (*e.g.,* for "megaprojects") requiring bidders on the prime contract to specify elements of the contract or specific subcontracts that are of a size that small businesses, including DBEs, can reasonably perform.

(3) On prime contracts not having DBE contract goals, requiring the prime contractor to provide subcontracting opportunities of a size that small businesses, including DBEs, can reasonably perform, rather than self-performing all the work involved.

(4) Identifying alternative acquisition strategies and structuring procurements to facilitate the ability of consortia or joint ventures consisting of small businesses, including DBEs, to compete for and perform prime contracts.

(5) To meet the portion of your overall goal you project to meet through DBE-neutral measures, ensuring that a reasonable number of prime contracts are of a size that small businesses, including DBEs, can reasonably perform.

(c) You must actively implement your program elements to foster small business participation. Doing so is a requirement of good faith implementation of your DBE program.

[76 FR 5097, Jan. 28, 2011, as amended at 89 FR 24966, Apr. 9, 2024; 90 FR 47980, Oct. 3, 2025]

Subpart C—Goals, Good Faith Efforts, and Counting

§ 26.41 What is the role of the statutory 10 percent goal in this program?

(a) The statutes authorizing this program provide that, except to the extent the Secretary determines otherwise, not less than 10 percent of the authorized funds are to be expended with DBEs.

(b) This 10 percent goal is an aspirational goal at the national level, which the Department uses as a tool in evaluating and monitoring DBEs' opportunities to participate in DOT-assisted contracts.

(c) The national 10 percent goal does not authorize or require recipients to set overall or contract goals at the 10 percent level, or any other particular level, or to take any special administrative steps if their goals are above or below 10 percent.

§ 26.43 Can recipients use set-asides or quotas as part of this program?

(a) You are not permitted to use quotas for DBEs on DOT-assisted contracts subject to this part.

(b) You may not set-aside contracts for DBEs on DOT-assisted contracts subject to this part, except that, in limited and extreme circumstances, you may use set-asides when no other method could be reasonably expected to redress egregious instances of discrimination.

§ 26.45 How do recipients set overall goals?

(a) ***General rule.***

(1) Except as provided in paragraph (a)(2) of this section, you must set an overall goal for DBE participation in your DOT-assisted contracts.

(2) If you are an FTA Tier II recipient who intends to operate a DBE-neutral program, or if you are an FAA recipient who reasonably anticipates awarding $250,000 or less in FAA prime contract funds in a Federal fiscal year, you are not required to develop overall goals for FTA or FAA, respectively, for that Federal fiscal year.

(b) Your overall goal must be based on demonstrable evidence of the availability of ready, willing, and able DBEs relative to all businesses ready, willing, and able to participate on your DOT-assisted contracts (hereafter, the "relative availability of DBEs"). The goal must reflect your determination of the level of DBE participation you would expect absent the effects of social and economic disadvantage. You cannot simply rely on either the 10 percent national goal, your previous overall goal, or past DBE participation rates in your program without reference to the relative availability of DBEs in your market.

(c) ***Step 1.*** You must begin your goal setting process by determining a base figure for the relative availability of DBEs. The following are examples of approaches that you may take toward determining a base figure. These examples are provided as a starting point for your goal setting process. Any percentage figure derived from one of these examples should be considered a basis from which you begin when examining all evidence available in your jurisdiction. These examples are not intended as an exhaustive list. Other methods or combinations of methods to determine a base figure may be used, subject to approval by the concerned operating administration.

(1) ***Use DBE Directories and Census Bureau Data.*** Determine the number of ready, willing and able DBEs in your market from your DBE directory. Using the Census Bureau's County Business Pattern (CBP) data base, determine the number of all ready, willing and able businesses available in your market that perform work in the same NAICS codes. (Information about the CBP data base may be obtained from the Census Bureau at their web site, *https://www.census.gov/programs-surveys/cbp.html;*) Divide the number of DBEs by the number of all businesses to derive a base figure for the relative availability of DBEs in your market.

(2) ***Use a bidders list.*** Determine the number of DBEs that have bid or quoted (successful and unsuccessful) on your DOT-assisted prime contracts or subcontracts in the past three years. Determine the number of all businesses that have bid or quoted (successful and unsuccessful) on prime or subcontracts in the same time period. Divide the number of DBE bidders and quoters by the number of all businesses to derive a base figure for the relative availability of DBEs in your market. When using this approach, you must establish a mechanism (documented in your goal submission) to directly capture data on DBE and non-DBE prime and subcontractors that submitted bids or quotes on your DOT-assisted contracts.

(3) Use data from a disparity study. Use a percentage figure derived from data in a valid, applicable disparity study. Any disparity study utilized must provide a detailed capacity analysis, including the methodology used.

(4) ***Use the goal of another DOT recipient.*** If another DOT recipient in the same, or substantially similar, market has set an overall goal in compliance with this rule, you may use that goal as a base figure for your goal.

(5) ***Alternative methods.*** Except as otherwise provided in this paragraph, you may use other methods to determine a base figure for your overall goal. Any methodology you choose must be based on demonstrable evidence of local market conditions and be designed to ultimately attain a goal that is rationally related to the relative availability of DBEs in your market. The exclusive use of a list of prequalified contractors or plan holders, or a bidders list that does not comply with the requirements of paragraph (c)(2) of this section, is not an acceptable alternative means of determining the availability of DBEs.

(d) ***Step 2.*** Once you have calculated a base figure, you must examine all of the evidence available in your jurisdiction to determine what adjustment, if any, is needed to the base figure to arrive at your overall goal. If the evidence does not suggest an adjustment is necessary, then no adjustment shall be made.

(1) There are many types of evidence that must be considered when adjusting the base figure. These include:

(i) The current capacity of DBEs to perform work in your DOT-assisted contracting program, as measured by the volume of work DBEs have performed in recent years;

(ii) Evidence from disparity studies conducted anywhere within your jurisdiction, to the extent it is not already accounted for in your base figure. To the extent that the disparity study provides a detailed capacity analysis, include the methodology used;

(iii) If your base figure is the goal of another recipient, you must adjust it for differences in your local market and your contracting program.

(2) If available, you must consider evidence from related fields that affect the opportunities for DBEs to form, grow and compete. These include, but are not limited to:

(i) Statistical disparities in the ability of DBEs to get the financing, bonding and insurance required to participate in your program;

(ii) Data on employment, self-employment, education, training and union apprenticeship programs, to the extent you can relate it to the opportunities for DBEs to perform in your program.

(3) If you attempt to make an adjustment to your base figure to account for the effects of an ongoing DBE program, the adjustment must be based on demonstrable evidence that is logically and directly related to the effect for which the adjustment is sought.

(e) Once you have determined a percentage figure in accordance with paragraphs (c) and (d) of this section, you should express your overall goal as follows:

(1) If you are an FHWA recipient, as a percentage of all Federal-aid highway funds you will expend in FHWA-assisted contracts in the forthcoming three fiscal years.

(2) If you are an FTA or FAA recipient, as a percentage of all FT or FAA funds (exclusive of FTA funds to be used for the purchase of transit vehicles) that you will expend in FTA or FAA-assisted contracts in the three forthcoming fiscal years.

(3) In appropriate cases, the FHWA, FTA or FAA Administrator may permit or require you to express your overall goal as a percentage of funds for a particular grant or project or group of grants and/or projects, including entire projects. Like other overall goals, a project goal may be adjusted to reflect changed circumstances, with the concurrence of the appropriate operating administration.

(i) A project goal is an overall goal, and must meet all the substantive and procedural requirements of this section pertaining to overall goals.

(ii) A project goal covers the entire length of the project to which it applies.

(iii) The project goal should include a projection of the DBE participation anticipated to be obtained during each fiscal year covered by the project goal.

(iv) The funds for the project to which the project goal pertains are separated from the base from which your regular overall goal, applicable to contracts not part of the project covered by a project goal, is calculated.

(f)

(1)

(i) If you set your overall goal on a fiscal year basis, you must submit it to the applicable DOT operating administration by August 1 at three-year intervals, based on a schedule established by the FHWA, FTA, or FAA, as applicable, and posted on that agency's website.

(ii) You may adjust your three-year overall goal during the three-year period to which it applies, in order to reflect changed circumstances. You must submit such an adjustment to the concerned operating administration for review and approval.

(iii) The operating administration may direct you to undertake a review of your goal if necessary to ensure that the goal continues to fit your circumstances appropriately.

(iv) While you are required to submit an overall goal to FHWA, FTA, or FAA only every three years, the overall goal and the provisions of Sec. 26.47(c) apply to each year during that three-year period.

(v) You may make, for informational purposes, projections of your expected DBE achievements during each of the three years covered by your overall goal. However, it is the overall goal itself, and not these informational projections, to which the provisions of section 26.47(c) of this part apply.

(2) If you are a recipient and set your overall goal on a project or grant basis as provided in paragraph (e)(3) of this section, you must submit the goal for review at a time determined by the FHWA, FTA or FAA Administrator, as applicable.

(3) You must include with your overall goal submission a description of the methodology you used to establish the goal, including your base figure and the evidence with which it was calculated, and the adjustments you made to the base figure and the evidence you relied on for the adjustments. You should also include a summary listing of the relevant available evidence in your jurisdiction and, where applicable, an explanation of why you did not use that evidence to adjust your base figure. You must also include your projection of the portions of the overall goal you expect to meet through DBE-neutral and DBE-conscious measures, respectively (*see* § 26.51(c)).

(4) You are not required to obtain prior operating administration concurrence with your overall goal. However, if the operating administration's review suggests that your overall goal has not been correctly calculated or that your method for calculating goals is inadequate, the operating administration may, after consulting with you, adjust your overall goal or require that you do so. The adjusted overall goal is binding on you. In evaluating the adequacy or soundness of the methodology used to derive the overall goal, the operating administration will be guided by goal setting principles and best practices identified by the Department in guidance issued pursuant to § 26.9.

(5) If you need additional time to collect data or take other steps to develop an approach to setting overall goals, you may request the approval of the concerned operating administration for an interim goal and/or goal-setting mechanism. Such a mechanism must:

(i) Reflect the relative availability of DBEs in your local market to the maximum extent feasible given the data available to you; and

(ii) Avoid imposing undue burdens on non-DBEs.

(6) Timely submission and operating administration approval of your overall goal is a condition of eligibility for DOT financial assistance.

(7) If you fail to establish and implement goals as provided in this section, you are not in compliance with this part. If you establish and implement goals in a way different from that provided in this part, you are not in compliance with this part. If you fail to comply with this requirement, you are not eligible to receive DOT financial assistance.

(g)

(1) In establishing an overall goal, you must provide for consultation and publication. This includes:

(i) Consultation with general contractor groups, community organizations, and other officials or organizations that could be expected to have information concerning the availability of disadvantaged and non-disadvantaged businesses and your efforts to establish a level playing field for the participation of DBEs. The consultation must include a scheduled, direct, interactive exchange (*e.g.,* a face-to-face meeting, video conference, teleconference) with as many interested stakeholders as possible focused on obtaining information relevant to the goal setting process, and it must occur before you are required to submit your methodology to the operating administration for review pursuant to paragraph (f) of this section. You must document in your goal submission the consultation process you engaged in. Notwithstanding paragraph (f)(4) of this section, you may not implement your proposed goal until you have complied with this requirement.

(ii) A published notice announcing your proposed overall goal before submission to the operating administration on August 1st. The notice must be posted on your official internet website and may be posted in any other sources (*e.g.,* trade association publications). If the proposed goal changes following review by the operating administration, the revised goal must be posted on your official internet website.

(2) At your discretion, you may inform the public that the proposed overall goal and its rationale are available for inspection during normal business hours at your principal office and for a 30-day comment period. Notice of the comment period must include addresses to which comments may be sent. The public comment period will not extend the August 1st deadline set in paragraph (f) of this section.

(h) Effective October 3, 2025 you are not required to update your overall goals until the UCP that covers you has completed the reevaluation process described in § 26.111.

[64 FR 5126, Feb. 2, 1999, as amended at 64 FR 34570, June 28, 1999; 65 FR 68951, Nov. 15, 2000; 68 FR 35553, June 16, 2003; 75 FR 5536, Feb. 3, 2010; 76 FR 5097, Jan. 28, 2011; 79 FR 59593, Oct. 2, 2014; 89 FR 24966, Apr. 9, 2024; 89 FR 55089, July 3, 2024; 90 FR 47980, Oct. 3, 2025]

§ 26.47 Can recipients be penalized for failing to meet overall goals?

(a) You cannot be penalized, or treated by the Department as being in noncompliance with this rule, because your DBE participation falls short of your overall goal, unless you have failed to administer your program in good faith.

(b) If you do not have an approved DBE program or overall goal, or if you fail to implement your program in good faith, you are in noncompliance with this part.

(c) If the awards and commitments shown on your Uniform Report of Awards or Commitments and Payments at the end of any fiscal year are less than the overall goal applicable to that fiscal year, you must do the following in order to be regarded by the Department as implementing your DBE program in good faith:

(1) Analyze in detail the reasons for the difference between the overall goal and your awards and commitments in that fiscal year;

(2) Establish specific steps and milestones to correct the problems you have identified in your analysis and to enable you to meet fully your goal for the new fiscal year;

(3)

(i) If you are a state highway agency; one of the 50 largest transit authorities as determined by the FTA; or an CORE 30 airport or other airport designated by the FAA, you must submit, within 90 days of the end of the fiscal year, the analysis and corrective actions developed under paragraphs (c)(1) and (2) of this section to the appropriate operating administration for approval. If the operating administration approves the report, you will be regarded as complying with the requirements of this section for the remainder of the fiscal year.

(ii) As a transit authority or airport not meeting the criteria of paragraph (c)(3)(i) of this section, you must retain analysis and corrective actions in your records for three years and make it available to FTA or FAA on request for their review.

(4) FHWA, FTA, or FAA may impose conditions on the recipient as part of its approval of the recipient's analysis and corrective actions including, but not limited to, modifications to your overall goal methodology, changes in your DBE-conscious/DBE-neutral split, or the introduction of additional DBE-neutral or DBE-conscious measures.

(5) You may be regarded as being in noncompliance with this Part, and therefore subject to the remedies in § 26.103 or § 26.105 of this part and other applicable regulations, for failing to implement your DBE program in good faith if any of the following things occur:

(i) You do not submit your analysis and corrective actions to FHWA, FTA, or FAA in a timely manner as required under paragraph (c)(3) of this section;

(ii) FHWA, FTA, or FAA disapproves your analysis or corrective actions; or

(iii) You do not fully implement the corrective actions to which you have committed or conditions that FHWA, FTA, or FAA has imposed following review of your analysis and corrective actions.

(d) If, as recipient, your Uniform Report of DBE Awards or Commitments and Payments or other information coming to the attention of FTA, FHWA, or FAA, demonstrates that current trends make it unlikely that you will achieve DBE awards and commitments that would be necessary to allow you to meet your overall goal at the end of the fiscal year, FHWA, FTA, or FAA, as applicable, may require you to make further good faith efforts, such as by modifying your DBE-conscious/DBE-neutral or introducing additional DBE-neutral or DBE-conscious measures for the remainder of the fiscal year.

(e) Effective October 3, 2025, you are not subject to this section until the UCP that covers you has completed the reevaluation process described in § 26.111.

[64 FR 5126, Feb. 2, 1999, as amended at 76 FR 5098, Jan. 28, 2011; 89 FR 24966, Apr. 9, 2024; 90 FR 47980, Oct. 3, 2025]

§ 26.49 What are the requirements for transit vehicle manufactures (TVMs) and for awarding DOT-assisted contracts to TVMs?

(a) If you are an FTA recipient, you must require in your DBE program that each TVM, as a condition of being authorized to bid or propose on FTA assisted transit vehicle procurements, certify that it has complied with the requirements of this section. You do not include FTA assistance used in transit vehicle procurements in the base amount from which your overall goal is calculated.

(1) Only those TVMs listed on FTA's list of eligible TVMs, or that have submitted a goal methodology to FTA that has been approved or has not been disapproved at the time of solicitation are eligible to bid.

(2) A TVM that fails to follow the requirements of this section and this part will be deemed as non-compliant, which will result in removal from FTA's eligible TVMs list and ineligibility to bid.

(3) An FTA recipient's failure to comply with the requirements set forth in paragraph (a) of this section may result in formal enforcement action or appropriate sanction as determined by FTA (*e.g.,* FTA declining to participate in the vehicle procurement).

(4) Within 30 days of becoming contractually required to procure a transit vehicle, an FTA recipient must report to FTA:

(i) The name of the TVM that was the successful bidder; and

(ii) The Federal share of the contractual commitment at that time.

(b) If you are a TVM, you must establish and submit to FTA an annual overall percentage goal for DBE participation.

(1) In setting your overall goal, you should be guided, to the extent applicable, by the principles underlying § 26.45. The base from which you calculate this goal is the amount of FTA financial assistance included in transit vehicle contracts on which you will bid on during the fiscal year in question, less the portion(s) attributable to the manufacturing process performed entirely by your own forces.

(i) You must consider and include in your base figure all domestic contracting opportunities made available to non-DBEs.

(ii) You must exclude from this base figure funds attributable to work performed outside the United States and its territories, possessions, and commonwealths.

(iii) In establishing an overall goal, you must provide for public participation. This includes consultation with interested parties consistent with § 26.45(g).

(2) The requirements of this part with respect to submission and approval of overall goals apply to you as they do to recipients, except that TVMs set and submit their goals annually and not on a triennial basis.

(c) TVMs must comply with the reporting requirements of § 26.11, including the requirement to submit the Uniform Report of DBE Awards or Commitments and Payments, in order to remain eligible to bid on FTA assisted transit vehicle procurements.

(d) TVMs must implement all other requirements of this part, except those relating to UCPs and DBE certification procedures.

(e) If you are an FHWA or FAA recipient, you may, with FHWA or FAA approval, use the procedures of this section with respect to procurements of vehicles or specialized equipment. If you choose to do so, then the manufacturers of the equipment must meet the same requirements (including goal approval by FHWA or FAA) that TVMs must meet in FTA assisted procurements.

(f) Recipients may establish project-specific goals for DBE participation in the procurement of transit vehicles from specialized manufacturers when a TVM cannot be identified.

(1) Project-specific goals established pursuant to this section are subject to the same review and approval and must be established as prescribed in the project goal provisions of § 26.45.

(2) FTA must approve the decision to use a project goal before the recipient issues a public solicitation for the vehicles in question.

(3) To support the request to develop a project goal, recipients must demonstrate that no TVMs are available to manufacture the vehicle.

[89 FR 24966, Apr. 9, 2024]

§ 26.51 What means do recipients use to meet overall goals?

(a) You must meet the maximum feasible portion of your overall goal by using DBE-neutral means of facilitating DBE-neutral participation. DBE-neutral participation includes any time a DBE wins a prime contract through customary competitive procurement procedures or is awarded a subcontract on a prime contract that does not carry a DBE contract goal.

(b) DBE-neutral means include, but are not limited to, the following:

(1) Arranging solicitations, times for the presentation of bids, quantities, specifications, and delivery schedules in ways that facilitate participation by DBEs and other small businesses and by making contracts more accessible to small businesses, by means such as those provided under § 26.39 of this part.

(2) Providing assistance in overcoming limitations such as inability to obtain bonding or financing (e.g., by such means as simplifying the bonding process, reducing bonding requirements, eliminating the impact of surety costs from bids, and providing services to help DBEs, and other small businesses, obtain bonding and financing);

(3) Providing technical assistance and other services;

(4) Carrying out information and communications programs on contracting procedures and specific contract opportunities (e.g., ensuring the inclusion of DBEs, and other small businesses, on recipient mailing lists for bidders; ensuring the dissemination to bidders on prime contracts of lists of potential subcontractors; provision of information in languages other than English, where appropriate);

(5) Implementing a supportive services program to develop and improve immediate and long-term business management, record keeping, and financial and accounting capability for DBEs and other small businesses;

(6) Providing services to help DBEs, and other small businesses, improve long-term development, increase opportunities to participate in a variety of kinds of work, handle increasingly significant projects, and achieve eventual self-sufficiency;

(7) Establishing a program to assist new, start-up firms, particularly in fields in which DBE participation has historically been low;

(8) Ensuring distribution of your DBE directory, through print and electronic means, to the widest feasible universe of potential prime contractors; and

(9) Assisting DBEs, and other small businesses, to develop their capability to utilize emerging technology and conduct business through electronic media.

(c) Each time you submit your overall goal for review by the concerned operating administration, you must also submit your projection of the portion of the goal that you expect to meet through DBE-neutral means and your basis for that projection. This projection is subject to approval by the concerned operating administration, in conjunction with its review of your overall goal.

(d) You must establish contract goals to meet any portion of your overall goal you do not project being able to meet using DBE-neutral means.

(e) The following provisions apply to the use of contract goals:

(1) You may use contract goals only on those DOT-assisted contracts that have subcontracting possibilities.

(2) You are not required to set a contract goal on every DOT-assisted contract. You are not required to set each contract goal at the same percentage level as the overall goal. The goal for a specific contract may be higher or lower than that percentage level of the overall goal, depending on such factors as the type of work involved, the location of the work, and the availability of DBEs for the work of the particular contract. However, over the period covered by your overall goal, you must set contract goals so that they will cumulatively result in meeting any portion of your overall goal you do not project being able to meet through the use of DBE-neutral means.

(3) Operating administration approval of each contract goal is not necessarily required. However, operating administrations may review and approve or disapprove any contract goal you establish.

(4) Your contract goals must provide for participation by all certified DBEs and must not be subdivided into group-specific goals.

(f) To ensure that your DBE program continues to be narrowly tailored to overcome the effects of social and economic disadvantage, you must adjust your use of contract goals as follows:

(1) If your approved projection under paragraph (c) of this section estimates that you can meet your entire overall goal for a given year through DBE-neutral means, you must implement your program without setting contract goals during that year, unless it becomes necessary in order meet your overall goal.

Example 1 to paragraph (f)(1): Your overall goal for Year I is 12 percent. You estimate that you can obtain 12 percent or more DBE participation through DBE-neutral measures, without any use of contract goals. In this case, you do not set any contract goals for the contracts that will be performed in Year I. However, if part way through Year I, your DBE awards or commitments are not at a level that would permit you to achieve your overall goal for Year I, you could begin setting DBE-conscious contract goals during the remainder of the year as part of your obligation to implement your program in good faith.

(2) If, during any year in which you are using contract goals, you determine that you will exceed your overall goal, you must reduce or eliminate the use of contract goals to the extent necessary to ensure that the use of contract goals does not result in exceeding the overall goal. If you determine that you will fall short of your overall goal, then you must make appropriate modifications in your use of DBE-neutral or DBE-conscious measures to allow you to meet the overall goal.

Example 2 to paragraph (f)(2): In Year II, your overall goal is 12 percent. You have estimated that you can obtain 5 percent DBE participation through use of DBE-neutral measures. You therefore plan to obtain the remaining 7 percent participation through use of DBE goals. By September, you have already obtained 11 percent DBE participation for the year. For contracts let during the remainder of the year, you use contract goals only to the extent necessary to obtain an additional one percent DBE participation. However, if you determine in September that your participation for the year is likely to be only 8 percent total, then you would increase your use of DBE-neutral or DBE-conscious means during the remainder of the year in order to achieve your overall goal.

(3) If the DBE participation you have obtained by DBE-neutral means alone meets or exceeds your overall goals for two consecutive years, you are not required to make a projection of the amount of your goal you can meet using such means in the next year. You do not set contract goals on any contracts in the next year. You continue using only DBE-neutral means to meet your overall goals unless and until you do not meet your overall goal for a year.

Example 3 to paragraph (f)(3): Your overall goal for Years I and Year II is 10 percent. The DBE participation you obtain through DBE-neutral measures alone is 10 percent or more in each year. (For this purpose, it does not matter whether you obtained additional DBE participation through using contract goals in these years.) In Year III and following years, you do not need to make a projection under paragraph (c) of this section of the portion of your overall goal you expect to meet using DBE-neutral means. You simply use DBE-neutral means to achieve your overall goals. However, if in Year VI your DBE participation falls short of your overall goal, then you must make a paragraph (c) of this section projection for Year VII and, if necessary, resume use of contract goals in that year.

(4) If you obtain DBE participation that exceeds your overall goal in two consecutive years using contract goals (*i.e.,* not through DBE-neutral means alone), you must reduce your use of contract goals proportionately in the following year.

Example 4 to paragraph (f)(4): In Years I and II, your overall goal is 12 percent, and you obtain 14 and 16 percent DBE participation, respectively. You have exceeded your goals over the two-year period by an average of 25 percent. In Year III, your overall goal is again 12 percent, and your paragraph (c) of this section projection estimates that you will obtain 4 percent DBE participation through DBE-neutral means and 8 percent through contract goals. You then reduce the contract goal projection by 25 percent (*i.e.,* from 8 to 6 percent) and set contract goals accordingly during the year. If in Year III you obtain 11 percent participation, you do not use this contract goal adjustment mechanism for Year IV, because there have not been two consecutive years of exceeding overall goals.

(g) In any year in which you project meeting part of your goal through DBE-neutral means and the remainder through contract goals, you must maintain data separately on DBE achievements in those contracts with and without contract goals, respectively. You must report this data to the concerned operating administration as provided in § 26.11.

(h) Effective October 3, 2025, you may not set any contract goals until the UCP that covers you has completed the reevaluation process described in § 26.111.

[64 FR 5126, Feb. 2, 1999, as amended at 76 FR 5098, Jan. 28, 2011; 79 FR 59595, Oct. 2, 2014; 89 FR 24967, Apr. 9, 2024; 90 FR 47981, Oct. 3, 2025]

§ 26.53 What are the good faith efforts procedures recipients follow in situations where there are contract goals?

(a) When you have established a DBE contract goal, you must award the contract only to a bidder/offeror who makes good faith efforts to meet it. You must determine that a bidder/offeror has made good faith efforts if the bidder/offeror does either of the following things:

(1) Documents that it has obtained enough DBE participation to meet the goal; or

(2) Documents that it made adequate good faith efforts to meet the goal, even though it did not succeed in obtaining enough DBE participation to do so. If the bidder/offeror does document adequate good faith efforts, you must not deny award of the contract on the basis that the bidder/offeror failed to meet the goal. See appendix A of this part for guidance in determining the adequacy of a bidder/offeror's good faith efforts.

(b) In your solicitations for DOT-assisted contracts for which a contract goal has been established, you must require the following:

(1) Award of the contract will be conditioned on meeting the requirements of this section;

(2) All bidders or offerors will be required to submit the following information to the recipient, at the time provided in paragraph (b)(3) of this section:

(i) The names and addresses of DBE firms that will participate in the contract;

(ii) A description of the work that each DBE will perform. To count toward meeting a goal, each DBE firm must be certified in a NAICS code applicable to the kind of work the firm would perform on the contract;

(iii) The dollar amount of the participation of each DBE firm participating;

(iv) Written documentation of the bidder/offeror's commitment to use a DBE subcontractor whose participation it submits to meet a contract goal; and

(v) Written confirmation from each listed DBE firm that it is participating in the contract in the kind and amount of work provided in the prime contractor's commitment. Each DBE listed to perform work as a regular dealer or distributor must confirm its participation according to the requirements of paragraph (c)(1) of this section.

(vi) If the contract goal is not met, evidence of good faith efforts (see Appendix A of this part). The documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract; and

(3)

(i) At your discretion, the bidder/offeror must present the information required by paragraph (b)(2) of this section—

(A) Under sealed bid procedures, as a matter of responsiveness, or with initial proposals, under contract negotiation procedures; or

(B) No later than 7 days after bid opening as a matter of responsibility. The 7 days shall be reduced to 5 days beginning January 1, 2017.

(ii) Provided that, in a negotiated procurement, such as a procurement for professional services, the bidder/offeror may make a contractually binding commitment to meet the goal at the time of bid submission or the presentation of initial proposals but provide the information required by paragraph (b)(2) of this section before the final selection for the contract is made by the recipient. This paragraph (b)(3)(ii) does not apply to a design-build procurement, which must follow the provisions in paragraph (e) of this section.

(c) You must make sure all information is complete and accurate and adequately documents the bidder/offeror's good faith efforts before committing yourself to the performance of the contract by the bidder/offeror.

(1) For each DBE listed as a regular dealer or distributor you must make a preliminary counting determination to assess its eligibility for 60 or 40 percent credit, respectively, of the cost of materials and supplies based on its demonstrated capacity and intent to perform as a regular dealer or distributor, as defined in § 26.55(e)(2)(iv)(A), (B), and (C) and (e)(3) under the contract at issue. Your preliminary determination shall be made based on the DBE's written responses to relevant questions and its affirmation that its subsequent performance of a commercially useful function will be consistent with the preliminary counting of such participation. Where the DBE supplier does not affirm that its participation will meet the specific requirements of either a regular dealer or distributor, you are required to make appropriate adjustments in counting such participation toward the bidder's good faith efforts to meet the contract goal. The bidder is responsible for verifying that the information provided by the DBE supplier is consistent with the counting of such participation toward the contract goal.

(2) [Reserved]

(d) If you determine that the apparent successful bidder/offeror has failed to meet the requirements of paragraph (a) of this section, you must, before awarding the contract, provide the bidder/offeror an opportunity for administrative reconsideration.

(1) As part of this reconsideration, the bidder/offeror must have the opportunity to provide written documentation or argument concerning the issue of whether it met the goal or made adequate good faith efforts to do so.

(2) Your decision on reconsideration must be made by an official who did not take part in the original determination that the bidder/offeror failed to meet the goal or make adequate good faith efforts to do so.

(3) The bidder/offeror must have the opportunity to meet in person with your reconsideration official to discuss the issue of whether it met the goal or made adequate good faith efforts to do so.

(4) You must send the bidder/offeror a written decision on reconsideration, explaining the basis for finding that the bidder did or did not meet the goal or make adequate good faith efforts to do so.

(5) The result of the reconsideration process is not administratively appealable to the Department of Transportation.

(e) In a design-build contracting situation, in which the recipient solicits proposals to design and build a project with minimal-project details at time of letting, the recipient may set a DBE goal that proposers must meet by submitting a DBE Open-Ended DBE Performance Plan (OEPP) with the proposal. The OEPP replaces the requirement to provide the information required in paragraph (b) of this section that applies to design-bid-build contracts. To be considered responsive, the OEPP must include a commitment to meet the goal and provide details of the types of subcontracting work or services (with projected dollar amount) that the proposer will solicit DBEs to perform. The OEPP must include an estimated time frame in which actual DBE subcontracts would be executed. Once the design-build contract is awarded, the recipient must provide ongoing monitoring and oversight to evaluate whether the design-builder is using good faith efforts to comply with the OEPP and schedule. The recipient and the design-builder may agree to make written revisions of the OEPP throughout the life of the project, *e.g.,* replacing the type of work items the design-builder will solicit DBEs to perform and/or adjusting the proposed schedule, as long as the design-builder continues to use good faith efforts to meet the goal.

(f)

(1)

(i) You must require that a prime contractor not terminate a DBE or any portion of its work listed in response to paragraph (b)(2) of this section (or an approved substitute DBE firm per paragraph (g) of this section) without your prior written consent, unless you cause the termination or reduction. A termination includes any reduction or underrun in work listed for a DBE not caused by a material change to the prime contract by the recipient. This requirement applies to instances that include, but are not limited to, when a prime contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm.

(ii) You must include in each prime contract a provision stating that:

(A) The contractor must utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the contractor obtains your written consent as provided in this paragraph (f); and

(B) Unless your consent is provided under this paragraph (f), the prime contractor must not be entitled to any payment for work or material unless it is performed or supplied by the listed DBE.

(2) You may provide such written consent only if you agree, for reasons stated in your concurrence document, that the prime contractor has good cause to terminate the listed DBE or any portion of its work.

(3) Good cause does not exist if the prime contractor seeks to terminate a DBE or any portion of its work that it relied upon to obtain the contract so that the prime contractor can self-perform the work for which the DBE contractor was engaged, or so that the prime contractor can substitute another DBE or non-DBE contractor after contract award. For purposes of this paragraph (f)(3), good cause includes the following circumstances:

(i) The listed DBE subcontractor fails or refuses to execute a written contract;

(ii) The listed DBE subcontractor fails or refuses to perform the work of its subcontract in a way consistent with normal industry standards. Provided, however, that good cause does not exist if the failure or refusal of the DBE subcontractor to perform its work on the subcontract results from the bad faith or discriminatory action of the prime contractor;

(iii) The listed DBE subcontractor fails or refuses to meet the prime contractor's reasonable, nondiscriminatory bond requirements;

(iv) The listed DBE subcontractor becomes bankrupt, insolvent, or exhibits credit unworthiness;

(v) The listed DBE subcontractor is ineligible to work on public works projects because of suspension and debarment proceedings pursuant to 2 CFR parts 180, 215, and 1200 or applicable State law;

(vi) You have determined that the listed DBE subcontractor is not a responsible contractor;

(vii) The listed DBE subcontractor voluntarily withdraws from the project and provides to you written notice of its withdrawal;

(viii) The listed DBE is ineligible to receive DBE credit for the type of work required;

(ix) A DBE owner dies or becomes disabled with the result that the listed DBE contractor is unable to complete its work on the contract; and

(x) Other documented good cause that you determine compels the termination of the DBE subcontractor.

(4) Before transmitting to you its request to terminate a DBE subcontractor or any portion of its work, the prime contractor must give notice in writing to the DBE subcontractor, with a copy to you sent concurrently, of its intent to request to terminate and the reason for the proposed request.

(5) The prime contractor's written notice must give the DBE 5 days to respond, advising you and the contractor of the reasons, if any, why it objects to the proposed termination of its subcontract/or portion thereof and why you should not approve the prime contractor's request. If required in a particular case as a matter of public necessity (*e.g.,* safety), you may provide a response period shorter than 5 days.

(6) In addition to post-award terminations, the provisions of this section apply to pre-award deletions or changes to DBEs or their listed work put forward by offerors in negotiated procurements.

(g) When a DBE subcontractor or any portion of its work is terminated by the prime contractor as provided in paragraph (f) of this section, or the firm fails to complete its work on the contract for any reason, including when work committed to a DBE is not countable or reduced due to overestimations made prior

to award, the prime contractor must use good faith efforts to include additional DBE participation to the extent needed to meet the contract goal. The good faith efforts shall be documented by the contractor. If the recipient requests documentation under this provision, the contractor shall submit the documentation within 7 days, which may be extended for an additional 7 days, if necessary, at the request of the contractor, and the recipient shall provide a written determination to the contractor stating whether or not good faith efforts have been demonstrated.

(h) You must include in each prime contract the contract clause required by § 26.13(b) stating that failure by the contractor to carry out the requirements of this part is a material breach of the contract and may result in the termination of the contract or such other remedies set forth in that section you deem appropriate if the prime contractor fails to comply with the requirements of this section.

(i) You must apply the requirements of this section to DBE bidders/offerors for prime contracts. In determining whether a DBE bidder/offeror for a prime contract has met a contract goal, you count the work the DBE has committed to performing with its own forces as well as the work that it has committed to be performed by DBE subcontractors and DBE suppliers.

(j) You must require the contractor awarded the contract to make available upon request a copy of all DBE subcontracts. The subcontractor shall ensure that all subcontracts or an agreement with DBEs to supply labor or materials require that the subcontract and all lower tier subcontractors be performed in accordance with this part's provisions.

[64 FR 5126, Feb. 2, 1999, as amended at 76 FR 5098, Jan. 28, 2011; 79 FR 59595, Oct. 2, 2014; 89 FR 24967, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.55 How is DBE participation counted toward goals?

(a) When a DBE participates in a contract, you count only the value of the work performed by the DBE toward DBE goals.

(1) Count the entire amount of that portion of a construction contract (or other contract not covered by paragraph (a)(2) of this section) that is performed by the DBE's own forces. Include the cost of supplies and materials obtained by the DBE for the work of the contract, including supplies purchased or equipment leased by the DBE (except supplies and equipment the DBE subcontractor purchases or leases from the prime contractor or its affiliate).

(2) Count the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a DOT-assisted contract, toward DBE goals, provided you determine the fee to be reasonable and not excessive as compared with fees customarily allowed for similar services.

(3) When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

(b) When a DBE performs as a participant in a joint venture, count a portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE performs with its own forces toward DBE goals.

(c) Count expenditures to a DBE contractor toward DBE goals only if the DBE is performing a commercially useful function on that contract.

(1) A DBE performs a commercially useful function when it is responsible for execution of the work of the contract and is carrying out its responsibilities by performing, managing, and supervising the work involved. To perform a commercially useful function, the DBE must also be responsible, with respect to materials and supplies used on the contract, for negotiating price, determining quality and quantity, ordering the material, and installing (where applicable) and paying for the material itself. To determine whether a DBE is performing a commercially useful function, you must evaluate the amount of work subcontracted, industry practices, whether the amount the firm is to be paid under the contract is commensurate with the work it is performing and the DBE credit claimed for its performance of the work, and other relevant factors.

(2) A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction, contract, or project through which funds are passed to obtain the appearance of DBE participation. In determining whether a DBE is such an extra participant, you must examine similar transactions, particularly those in which DBEs do not participate.

(3) If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of its contract with its own work force, or the DBE subcontracts a greater portion of the work of a contract than would be expected within normal industry practice for the type of work involved, you must presume that it is not performing a commercially useful function.

(4) When a DBE is presumed not to be performing a commercially useful function as provided in paragraph (c)(3) of this section, the DBE may present evidence to rebut this presumption. You may determine that the firm is performing a commercially useful function given the type of work involved and normal industry practices.

(5) Your decisions on commercially useful function matters are subject to review by the concerned operating administration, but are not administratively appealable to DOT.

(d) Use the following factors in determining whether a DBE trucking company is performing a commercially useful function:

(1) The DBE must be responsible for the management and supervision of the entire trucking operation for which it is responsible on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting DBE goals.

(2) The DBE must itself own and operate at least one fully licensed, insured, and operational truck used on the contract.

(3) The DBE receives credit for the total value of the transportation services it provides on the contract using trucks it owns, insures, and operates using drivers it employs.

(4) The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the contract.

(5) The DBE may also lease trucks from a non-DBE firm, including from an owner-operator. The DBE that leases trucks equipped with drivers from a non-DBE is entitled to credit for the total value of transportation services provided by non-DBE leased trucks equipped with drivers not to exceed the value of transportation services on the contract provided by DBE-owned trucks or leased trucks with DBE employee drivers. Additional participation by non-DBE owned trucks equipped with drivers

receives credit only for the fee or commission it receives as a result of the lease arrangement. If a recipient chooses this approach, it must obtain written consent from the appropriate DOT operating administration.

Example to paragraph (d)(5): DBE Firm X uses two of its own trucks on a contract. It leases two trucks from DBE Firm Y and six trucks equipped with drivers from non-DBE Firm Z. DBE credit would be awarded for the total value of transportation services provided by Firm X and Firm Y, and may also be awarded for the total value of transportation services provided by four of the six trucks provided by Firm Z. In all, full credit would be allowed for the participation of eight trucks. DBE credit could be awarded only for the fees or commissions pertaining to the remaining trucks Firm X receives as a result of the lease with Firm Z.

(6) The DBE may lease trucks without drivers from a non-DBE truck leasing company. If the DBE leases trucks from a non-DBE truck leasing company and uses its own employees as drivers, it is entitled to credit for the total value of these hauling services.

Example to paragraph (d)(6): DBE Firm X uses two of its own trucks on a contract. It leases two additional trucks from non-DBE Firm Z. Firm X uses its own employees to drive the trucks leased from Firm Z. DBE credit would be awarded for the total value of the transportation services provided by all four trucks.

(7) For purposes of this paragraph (d), a lease must indicate that the DBE has exclusive use of and control over the truck. This does not preclude the leased truck from working for others during the term of the lease with the consent of the DBE, so long as the lease gives the DBE absolute priority for use of the leased truck. Leased trucks must display the name and identification number of the DBE.

(e) Count expenditures with DBEs for materials or supplies toward DBE goals as provided in the following:

(1)

(i) If the materials or supplies are obtained from a DBE manufacturer, count 100 percent of the cost of the materials or supplies.

(ii) For purposes of this paragraph (e)(1), a manufacturer is a firm that owns (or leases) and operates a factory or establishment that produces, on the premises, the materials, supplies, articles, or equipment required under the contract and of the general character described by the specifications. Manufacturing includes blending or modifying raw materials or assembling components to create the product to meet contract specifications. When a DBE makes minor modifications to the materials, supplies, articles, or equipment, the DBE is not a manufacturer. Minor modifications are additional changes to a manufactured product that are small in scope and add minimal value to the final product.

(2)

(i) If the materials or supplies are purchased from a DBE regular dealer, count 60 percent of the cost of the materials or supplies (including transportation costs).

(ii) For purposes of this section, a regular dealer is a firm that owns (or leases) and operates, a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in sufficient quantities, and regularly sold or leased to the public in the usual course of business.

(iii) Items kept and regularly sold by the DBE are of the "general character" when they share the same material characteristics and application as the items specified by the contract.

(iv) You must establish a system to determine that a DBE regular dealer per paragraph (e)(2)(iv)(A) of this section, over a reasonable period of time, keeps sufficient quantities and regularly sells the items in question. This system must also ensure that a regular dealer of bulk items per (e)(2)(iv)(B) of this section owns/leases and operates distribution equipment for the products it sells. This requirement may be administered through questionnaires, inventory records reviews, or other methods to determine whether each DBE supplier has the demonstrated capacity to perform a commercially useful function (CUF) as a regular dealer prior to its participation. The system you implement must be maintained and used to identify all DBE suppliers with capacity to be eligible for 60 percent credit, contingent upon the performance of a CUF. This requirement is a programmatic safeguard apart from that described in § 26.53(c)(1).

(A) To be a regular dealer, the firm must be an established business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question. A DBE supplier performs a CUF as a regular dealer and receives credit for 60 percent of the cost of materials or supplies (including transportation cost) when all, or at least 51 percent of, the items under a purchase order or subcontract are provided from the DBE's inventory, and when necessary, any minor quantities delivered from and by other sources are of the general character as those provided from the DBE's inventory.

(B) A DBE may be a regular dealer in such bulk items as petroleum products, steel, concrete or concrete products, gravel, stone, or asphalt without owning and operating a place of business as provided in paragraph (e)(2)(ii) of this section if the firm both owns and operates distribution equipment used to deliver the products. Any supplementing of regular dealers' own distribution equipment must be by a long-term operating lease and not on an ad hoc or contract-by-contract basis.

(C) A DBE supplier of items that are not typically stocked due to their unique characteristics (*e.g.,* limited shelf life or items ordered to specification) should be considered in the same manner as a regular dealer of bulk items per paragraph (e)(2)(iv)(B) of this section. If the DBE supplier of these items does not own or lease distribution equipment, as descried above, it is not a regular dealer.

(D) Packagers, brokers, manufacturers' representatives, or other persons who arrange, facilitate, or expedite transactions are not regular dealers within the meaning of paragraph (e)(2) of this section.

(3) If the materials or supplies are purchased from a DBE distributor that neither maintains sufficient inventory nor uses its own distribution equipment for the products in question, count 40 percent of the cost of materials or supplies (including transportation costs). A DBE distributor is an established business that engages in the regular sale or lease of the items specified by the contract. A DBE distributor assumes responsibility for the items it purchases once they leave the point of origin (*e.g.,* a manufacturer's facility), making it liable for any loss or damage not covered by the carrier's insurance. A DBE distributor performs a CUF when it demonstrates ownership of the items in question and assumes all risk for loss or damage during transportation, evidenced by the terms of the purchase order or a bill of lading (BOL) from a third party, indicating Free on Board (FOB) at the point of origin or similar terms that transfer responsibility of the items in question to the DBE

distributor. If these conditions are met, DBE distributors may receive 40 percent for drop-shipped items. Terms that transfer liability to the distributor at the delivery destination (*e.g.,* FOB destination), or deliveries made or arranged by the manufacturer or another seller do not satisfy this requirement.

(4) With respect to materials or supplies purchased from a DBE that is neither a manufacturer, a regular dealer, nor a distributor, count the entire amount of fees or commissions charged that you deem to be reasonable, including transportation charges for the delivery of materials or supplies. Do not count any portion of the cost of the materials and supplies themselves.

(5) You must determine the amount of credit awarded to a firm for the provisions of materials and supplies (*e.g.,* whether a firm is acting as a regular dealer, distributor, or a transaction facilitator) on a contract-by-contract basis.

(f) If a firm is not currently certified as a DBE in accordance with the standards of subpart D of this part at the time of the execution of the contract, do not count the firm's participation toward any DBE goals, except as provided for in § 26.87(j)).

(g) Do not count the dollar value of work performed under a contract with a firm after it has ceased to be certified toward your overall goal.

(h) Do not count the participation of a DBE subcontractor toward a contractor's final compliance with its DBE obligations on a contract until the contractor has paid the DBE the amount being counted.

(i) Effective October 3, 2025, you may not count any DBE participation toward DBE goals until the UCP that covers you has completed the reevaluation process described in § 26.111.

[64 FR 5126, Feb. 2, 1999, as amended at 65 FR 68951, Nov. 15, 2000; 68 FR 35554, June 16, 2003; 79 FR 59595, Oct. 2, 2014; 89 FR 24968, Apr. 9, 2024; 89 FR 55089, July 3, 2024; 90 FR 47982, Oct. 3, 2025]

Subpart D—Certification Standards

§ 26.61 Burden of proof

(a) In determining whether to certify a firm, the certifier must apply the standards of this subpart. Unless the context indicates otherwise, singular terms include their plural forms and vice versa.

(b) The firm has the burden of demonstrating, by a preponderance of the evidence, *i.e.,* more likely than not, that it satisfies all of the requirements in this subpart. In determining whether the firm has met its burden, the certifier must consider all the information in the record, viewed as a whole. In a decertification proceeding the certifier bears the burden of proving, by a preponderance of the evidence, that the firm is no longer eligible for certification under the rules of this part.

[89 FR 24969, Apr. 9, 2024, as amended at 90 FR 47982, Oct. 3, 2025]

§ 26.63 General certification rules.

(a) ***General rules.*** Except as otherwise provided:

(1) The firm must be for-profit and engaged in business activities.

(2) In making eligibility determinations, a certifier may not consider whether a firm performs a commercially useful function (CUF), or the potential effect on goals or counting.

(3) A certifier cannot condition eligibility on State prequalification requirements for bidding on contracts.

(4) Certification is not a warranty of competence or suitability.

(5) A certifier determines eligibility based on the evidence it has at the time of its decision, not on the basis of historical or outdated information, giving full effect to the "curative measures" provisions of this part.

(6) Entering into a fraudulent transaction or presenting false information to obtain or maintain DBE certification is disqualifying.

(b) ***Indirect ownership.*** A subsidiary (*i.e.,* S) that SEDOs own and control indirectly is eligible, if it satisfies the other requirements of this part and only under the following circumstances.

(1) ***Look-through.*** SEDOs own at least 51 percent of S through their ownership of P (*i.e.,* the parent firm) as shown in the examples following.

(2) ***Control.*** SEDOs control P, and P controls S.

(3) ***One tier of separation.*** The SEDOs indirectly own S through P and no other intermediary. That is, no applicant or DBE may be more than one entity (P) removed from its individual SEDOs.

(4) ***Examples.*** The following examples assume that S and its SEDOs satisfy all other requirements in this part.

(i) ***Example 1 to paragraph (b)(4).*** SEDOs own 100 percent of P, and P owns 100 percent of S. S is eligible for certification.

(ii) ***Example 2 to paragraph (b)(4).*** Same facts as Example 1, except P owns 51 percent of S. S is eligible.

(iii) ***Example 3 to paragraph (b)(4).*** SEDOs own 80 percent of P, and P owns 70 percent of S. S is eligible because SEDOs indirectly own 56 percent of S. The calculation is 80 percent of 70 percent or .8 × .7 = .56.

(iv) ***Example 4 to paragraph (b)(4).*** SEDOs own and control P, and they own 52 percent of S by operation of this paragraph (b). However, a non-SEDO controls S. S is ineligible.

(v) ***Example 5 to paragraph (b)(4).*** SEDOs own 60 percent of P, and P owns 51 percent of S. S is ineligible because SEDOs own just 31 percent of S.

(vi) ***Example 6 to paragraph (b)(4).*** P indirectly owns and controls S and has other affiliates. S is eligible only if its gross receipts, plus those of all of its affiliates, do not exceed the applicable small business size cap of § 26.65. Note that all of P's affiliates are affiliates of S by virtue of P's ownership and/or control of S.

(c) ***Indian Tribes, NHOs, and ANCs*** —

(1) ***Indian Tribes and NHOs.*** A firm that is owned by an Indian Tribe or Native Hawaiian organization (NHO), rather than by Indians or Native Hawaiians as individuals, is eligible if it meets all other certification requirements in this part.

(2) ***Alaska Native Corporations (ANCs).***

(i) Notwithstanding any other provisions of this subpart, a subsidiary corporation, joint venture, or partnership entity of an ANC is eligible for certification if it meets all the following requirements:

(A) The Settlement Common Stock of the underlying ANC and other stock of the ANC held by holders of the Settlement Common Stock and by Natives and descendants of Natives represents a majority of both the total equity of the ANC and the total voting power of the corporation for purposes of electing directors;

(B) The shares of stock or other units of common ownership interest in the subsidiary, joint venture, or partnership entity held by the ANC and by holders of its Settlement Common Stock represent a majority of both the total equity of the entity and the total voting power of the entity for the purpose of electing directors, the general partner, or principal officers; and

(C) The subsidiary, joint venture, or partnership entity has been certified by the Small Business Administration under the 8(a) or small disadvantaged business program.

(ii) As a certifier to whom an ANC-related entity applies for certification, a certifier must not use the Uniform Certified Application. The certifier must obtain from the firm documentation sufficient to demonstrate that the entity meets the requirements of paragraph (c)(2)(i) of this section. The certifier must also obtain sufficient information about the firm to allow the certifier to administer its program (*e.g.,* information that would appear in a UCP directory).

(iii) If an ANC-related firm does not meet all the conditions of paragraph (c)(2)(i) of this section, then it must meet the requirements of paragraph (c)(1) of this section in order to be certified.

[89 FR 24969, Apr. 9, 2024]

§ 26.65 Business size determinations.

(a) ***By NAICS Code.*** A firm (including its affiliates) must be a small business, as defined by the Small Business Administration (SBA). The certifier must apply the SBA business size limit in 13 CFR part 121 which corresponds to the applicable primary industry classifications (NAICS codes). The firm is ineligible when its affiliated "receipts" (computed on a cash basis), as defined in 13 CFR 121.104(a) and averaged over the firm's preceding five fiscal years, exceed the applicable SBA size cap(s).

(b) ***Statutory cap.*** Even if a firm is a small business under paragraph (a) of this section, it is ineligible to perform DBE work on FHWA or FTA assisted contracts if its affiliated annual gross receipts, as defined in 13 CFR 121.104, averaged over the firm's previous three fiscal years exceed $30.72 million (as of March 1, 2024). The Department will adjust this amount annually and post the adjusted amount on its website available at *https://www.transportation.gov/DBEsizestandards*.

[89 FR 24970, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.67 Social and economic disadvantage.

(a) ***Non-presumptive Disadvantage.*** All applicants must demonstrate social and economic disadvantage (SED) affirmatively based on their own experiences and circumstances within American society, and without regard to race or sex.

(1) To satisfy the SED requirement and ensure all determinations of disadvantage are not based in whole or in part on race or sex, an owner must provide the certifier a Personal Narrative (PN) that establishes the existence of disadvantage by a preponderance of the evidence based on individualized proof regarding specific instances of economic hardship, systemic barriers, and denied opportunities that impeded the owner's progress or success in education, employment, or business, including obtaining financing on terms available to similarly situated, non-disadvantaged persons.

(2) The PN must state how and to what extent the impediments caused the owner economic harm, including a full description of type and magnitude, and must establish the owner is economically disadvantaged in fact relative to similarly situated non-disadvantaged individuals.

(3) The owner must attach to the PN a current PNW statement and any other financial information he considers relevant.

(b) [Reserved]

[90 FR 47982, Oct. 3, 2025]

§ 26.68 Personal net worth.

(a) ***General.*** An owner whose PNW exceeds $2,047,000 is not presumed economically disadvantaged. The Department will adjust the PNW cap pursuant to paragraph (d) of this section.

(b) ***Required documents.*** Each owner on whom the firm relies for certification must submit a DOE and a corroborating personal net worth (PNW) statement, including required attachments. The owner must report PNW on the form, available at *https://www.Transportation.gov/DBEFORMS*. A certifier may require an owner to provide additional information on a case-by-case basis to verify the accuracy and completeness of the PNW statement. The certifier must have a legitimate and demonstrable need for the additional information.

(c) ***Reporting.*** The following rules apply without regard to State community property, equitable distribution, or similar rules. The owner reports assets and liabilities that she owns or is deemed to own. Ownership tracks title to the asset or obligor status on the liability except where otherwise provided or when the transaction results in evasion or abuse.

(1) The owner excludes her ownership interest in the applicant or DBE.

(2) The owner excludes her share of the equity in her primary residence. There is no exclusion when the SEDO does not own the home.

Example 1 to paragraph (c)(2): The owner and her spouse hold joint title to their primary residence, for which they paid $300,000 and are coequal debtors on a bank mortgage and a home equity line of credit with current combined balances of $150,000. The owner may exclude her $75,000 share of the $150,000 of total equity.

(3) The owner includes the full value of the contents of her primary residence unless she cohabits with a spouse or domestic partner, in which case she excludes only 50 percent of those assets.

(4) The owner includes the value of all motor vehicles, including watercraft and ATVs, titled in her name or of which she is the principal operator.

(5) The owner excludes the liabilities of any other party and those contingent on a future event or of undetermined value as of the date of the PNW Statement.

(6) The owner includes her proportional share of the balance of a debt on which she shares joint and severable liability with other primary debtors.

Example 2 to paragraph (c)(6): When the owner co-signs a debt instrument with two other individuals, the rule considers her liable for one-third of the current loan balance.

(7) The owner includes assets transferred to relatives or related entities within the two years preceding any UCA or DOE, when the assets so transferred during the period have an aggregate value of more than $20,000. Relatives include the owner's spouse or domestic partner, children (whether biological, adopted or stepchildren), siblings (including stepsiblings and those of the spouse or domestic partner), and parents (including stepparents and those of the spouse or domestic partner). Related entities include for-profit privately held companies of which any relative is an owner, officer, director, or equivalent; and family or other trusts of which the owner or any relative is grantor, trustee, or beneficiary, except when the transfer is irrevocable.

(8) The owner excludes direct payments, on behalf of immediate family members or their children, to unrelated providers of healthcare, education, or legal services.

(9) The owner excludes direct payments to providers of goods and services directly related to a celebration of an immediate family member's or that family member's child's significant, normally non-recurring life event.

(10) The owner excludes from net worth all assets in qualified retirement accounts but must report those accounts, the value of assets in them, and any significant terms and restrictions concerning the assets' use, to the certifier.

(d) ***Regulatory adjustments.***

(1) The Department will adjust the PNW cap by May 9, 2027 by multiplying $1,600,000 by the growth in total household net worth since 2019 as described by “Financial Accounts of the United States: Balance Sheet of Households (Supplementary Table B.101.h)” produced by the Board of Governors of the Federal Reserve (*https://www.federalreserve.gov/releases/z1/*), and normalized by the total number of households as collected by the Census in “Families and Living Arrangements” (*https://www.census.gov/topics/families/families-and-households.html*) to account for population growth. The Department will adjust the PNW cap every 3 years on the anniversary of the adjustment date described in this section. The Department will post the adjustments on the Departmental Office of Civil Rights' web page, available at *https://www.Transportation.gov/*DBEPNW. Each such adjustment will become the currently applicable PNW limit for purposes of this regulation.

(2) The Department will use formula 1 to this paragraph (d)(2) to adjust the PNW limit:

Formula 1 to Paragraph (d)

$$\text{Future Year PNW Cap} = [\$1{,}600{,}000] * \frac{\text{Q1-Q4 Average Household Net Worth of Future Year / Total Households of Future Year}}{\text{Q1-Q4 Average Household Net worth of 2019 (\$106,722,704 million / Total Households of 2019 (128,579)}}$$

(e) ***Confidentiality.*** Notwithstanding any provision of Federal or State law, a certifier must not release an individual's PNW statement nor any documents pertaining to it to any third party without the written consent of the submitter. Provided, that you must transmit this information to DOT in any certification appeal proceeding under § 26.89 or to any other State to which the individual's firm has applied for certification under § 26.85.

[89 FR 24971, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.69 Ownership.

(a) ***General rule.*** A SEDO must own at least 51 percent of each class of ownership of the firm. Each SEDO whose ownership is necessary to the firm's eligibility must demonstrate that her ownership satisfies the requirements of this section. If not, the firm is ineligible.

(b) ***Overall Requirements.*** A SEDO's acquisition and maintenance of an ownership interest meets the requirements of this section only if the SEDO demonstrates the following:

(1) ***Acquisition.*** The SEDO acquires ownership at fair value and by one or more "investments," as defined in paragraph (c) of this section.

(2) ***Proportion.*** No owner derives benefits or bears burdens that are clearly disproportionate to their ownership shares.

(3) ***Maintenance.*** This section's requirements continue to apply after the SEDO's acquisition and the firm's certification. That is, the SEDO must maintain her investment and its proportion relative to those of other owners.

(i) The SEDO may not withdraw or revoke her investment.

(ii) When an existing co-owner contributes significant, additional, post-acquisition cash or property to the firm, the SEDO must increase her own investment to a level not clearly disproportionate to the non-SEDO's investment.

(A) ***Example 1 to paragraph (b)(3)(ii).*** SEDO and non-SEDO own DBE 60/40. Their respective investments are approximately $600,000 and $400,000. The DBE has operated its business under this ownership and with this capitalization for 2 years. In Year 3, the non-SEDO contributes a $2 million asset to the business. The SEDO, as a result, owns 60 percent of a $2 million asset without any additional outlay. Her ownership interest, assuming no other pertinent facts, is worth $1.2 million more than it was before. Unless the SEDO increases her investment significantly, it is clearly disproportionate to the non-SEDO's investment and to her nominal 60 percent ownership. She has not maintained her investment.

(B) ***Example 2 to paragraph (b)(3)(ii).*** Same facts except that the DBE purchases the asset with a combination of 30 percent operating income and 70 percent proceeds of a bank loan. The SEDO maintains her investment because it remains in proportion to the non-SEDO's investment and to the value of her 60 percent ownership interest.

(C) ***Example 3 to paragraph (b)(3)(ii).*** Same facts except that the non-SEDO, not a bank, is the DBE's creditor. The SEDO has not maintained her investment because the benefits and burdens of her ownership are clearly disproportionate to those of the non-SEDO. The transaction may also raise § 26.71 concerns.

(iii) An organic increase in the value of the business does not affect maintenance because the value of the owners' investments remains proportional. In Example 2 above, the SEDO and the non-SEDO own the new asset at 60 percent and 40 percent of its net value of $60,000.

(c) ***Investments.*** A SEDO may acquire ownership by purchase, capital contribution, or gift. Subject to the other requirements of this section, each is considered an "investment" in the firm, as are additional purchases, contributions, and qualifying gifts.

(1) Investments are unconditional and at full risk of loss.

(2) Investments include a significant outlay of the SEDO's own money.

(3) For purposes of this part, title determines ownership of assets used for investments and of ownership interests themselves. This rule applies regardless of contrary community property, equitable distribution, banking, contract, or similar laws, rules, or principles.

(i) The person who has title to the asset owns it in proportion to her share of title.

(ii) However, the title rule is deemed not to apply when it produces a certification result that is manifestly unjust.

(4) If the SEDO jointly (50/50) owns an investment of cash or property, the SEDO may claim at least a 51 percent ownership interest only if the other joint owner formally transfers to the SEDO enough of his ownership in the invested asset(s) to bring the SEDO's investment to at least 51 percent of all investments in the firm. Such transfers may be gifts described in paragraph (e) of this section.

(d) ***Purchases and capital contributions.***

(1) A purchase of an ownership interest is an investment when the consideration is entirely monetary and not a trade of property or services.

(2) Capital that the SEDO contributes directly to the company is an investment when the contribution is all cash or a combination of cash and tangible property and/or realty.

(3) Contributions of time, labor, services, and the like are not investments or components of investments.

(4) Loans are not investments. The proceeds of loans may be investments to the extent that they finance the SEDO's qualifying purchase or capital contribution.

(5) Debt-financed purchases or capital contributions are investments when they comply with the rules in this section and in § 26.70.

(6) Guarantees are not investments.

(7) The firm's purchases or sales of property, including ownership in itself or other companies, are not the SEDO's investments.

(8) Other persons' or entities' purchases or capital contributions are not the SEDO's investments.

(e) ***Gifts.*** A gift to the SEDO is an investment when it meets the requirements of this section. The gift rules apply to partial gifts, bequests, inheritances, trust distributions, and transfers for inadequate consideration. They apply to gifts of ownership interests and to gifts of cash or property that the SEDO invests. The following requirements apply to gifts on which the SEDO relies for her investment.

(1) The transferor/donor is or immediately becomes uninvolved with the firm in any capacity and in any other business that contracts with the firm other than as a lessor or provider of standard support services;

(2) The transferor does not derive undue benefit; and

(3) A writing documents the gift. When the SEDO cannot reasonably produce better evidence, a receipt, cancelled check, or transfer confirmation suffices, if the writing identifies transferor, transferee, amount or value, and date.

(f) ***Curative measures.*** The rules of this section do not prohibit transactions that further the objectives of, and compliance with, the provisions of this part. A SEDO or firm may enter into legitimate transactions, alter the terms of ownership, make additional investments, or bolster underlying documentation in a good faith effort to remove, surmount, or correct defects in eligibility, as long as the actions are consistent with this part.

(1) The certifier may notify the firm of eligibility concerns and give the firm time, if the firm wishes, to attempt to remedy impediments to certification.

(2) The firm may, of its own volition, take curative action up to the time of the certifier's decision. However, it must present evidence of curation before the certifier's decision.

(3) The certifier may provide general assistance and guidance but not professional (legal, accounting, valuation, etc.) advice or opinions.

(4) While the certifier may not affirmatively impede attempts to cure, it may maintain its decision timeline and make its decision based on available evidence.

(5) The certifier must deny or remove certification when the firm's efforts or submissions violate the rules in paragraph (g) of this section.

(g) ***Anti-abuse rules.***

(1) The substance and not the form of transactions drives the eligibility determination.

(2) The certifier must deny applications based on sham transactions or false representations, and it must decertify DBEs that engage in or make them. Transactions or representations designed to evade or materially mislead subject the firm to the same consequences.

(3) Fraud renders the firm ineligible and subjects it to sanctions, suspension, debarment, criminal prosecution, civil litigation, and any other consequence or recourse not proscribed in this part.

Example 1 to paragraph (g)(3): SEDO claims an investment consisting of a contribution of equipment and a significant amount of her own cash. She shows that she transferred title to the equipment and wrote a check from an account she alone owns. She does not disclose that her brother-in-law lent her the money and she must repay him. The firm is ineligible under paragraphs (g)(1) and (2) of this section.

[89 FR 24972, Apr. 9, 2024]

§ 26.70 Debt-financed investments.

(a) Subject to the other provisions of this subpart, a SEDO may borrow money to *finance* a § 26.69(c) investment entirely or partially if the SEDO has paid, on a net basis, at least 15 percent of the total value of the investment by the time the firm applies for certification.

Example 1 to paragraph (a) introductory text: A SEDO who borrows $9,000 of her $10,000 cash investment in Applicant, Inc., must have repaid, from her own funds, at least $500 of the loan's principal by the time Applicant, Inc. applies for certification.

Example 2 to paragraph (a) introductory text: A SEDO who finances $8,000 of a $10,000 investment in Applicant may apply for Applicant's certification at any time.

Example 3 to paragraph (a) introductory text: A SEDO who contributes to the Applicant equipment worth $40,000, which she purchased with $10,000 of her own money and $30,000 of seller financing may apply for Applicant's certification at any time.

(1) The SEDO pays the net 15 percent portion of the investment to Seller or Applicant (as the case may be) from her own, not borrowed, money.

(2) Money that the SEDO receives as a § 26.69(e) gift is her own money.

(3) The firm, whether Applicant or DBE, does not finance any part of the investment, directly or indirectly.

(b) The loan is real, enforceable, not in default, not offset by another agreement, and on standard commercial, arm's length terms. The following conditions also apply.

(1) The SEDO is the sole debtor.

(2) The firm is not party to the loan in any capacity, including as a guarantor.

(3) The SEDO does not rely on the company's credit or other resources to repay any part of the debt or otherwise to finance any part of her investment.

(4) The loan agreement requires level, regularly recurring payments of principal and interest, according to a standard amortization schedule, at least until the SEDO satisfies requirements in paragraph (a) of this section.

(5) The loan agreement permits prepayments, including by refinancing.

(c) If the creditor forgives or cancels all or part of the debt, or the SEDO defaults, the entire debt-financed portion of the SEDO's purchase or capital contribution is no longer an investment.

Example 4 to paragraph (c): SEDO finances $40,000 of a $50,000 investment, and the firm becomes certified. When the SEDO has repaid half of the loan's principal and associated interest, the creditor forgives the remaining $20,000 debt. The SEDO's investment is now $10,000.

(d) Paragraph (c) of the section does not prohibit refinancing with debt that meets the requirements of this section or preclude prompt curation under § 26.69(f).

[89 FR 24973, Apr. 9, 2024]

§ 26.71 Control.

(a) ***General rules.***

(1) One or more SEDOs of the firm must control it.

(2) Control determinations must consider all pertinent facts, viewed together and in context.

(3) A firm must have operations in the business for which it seeks certification at the time it applies. Certifiers do not certify plans or intentions, or issue contingent or conditional certifications.

(b) ***SEDO as final decision maker.*** A SEDO must be the ultimate decision maker in fact, regardless of operational, policy, or delegation arrangements.

(c) ***Governance.*** Governance provisions may not require that any SEDO obtain concurrence or consent from a non-SEDO to transact business on behalf of the firm.

(1) ***Highest officer position.*** A SEDO must hold the highest officer position in the company (*e.g.,* chief executive officer or president).

(2) ***Board of directors.*** Except as detailed in paragraph (c)(4) of this section, a SEDO must have present control of the firm's board of directors, or other governing body, through the number of eligible votes.

(i) ***Quorum requirements.*** Provisions for the establishment of a quorum must not block the SEDO from calling a meeting to vote and transact business on behalf of the firm.

(ii) ***Shareholder actions.*** A SEDO's authority to change the firm's composition via shareholder action does not prove control within the meaning of paragraph (c) of this section.

(3) ***Partnerships.*** In a partnership, at least one SEDO must serve as a general partner, with control over all partnership decisions.

(4) ***Exception.*** Bylaws or other governing provisions that require non-SEDO consent for extraordinary actions generally do not contravene the rules in paragraph (c) of this section. Non-exclusive examples are a sale of the company or substantially all of its assets, mergers, and a sudden, wholesale change of type of business.

(d) ***Expertise.*** At least one SEDO must have an overall understanding of the business and its essential operations sufficient to make sound managerial decisions not primarily of an administrative nature. The requirements of this paragraph (d) vary with type of business, degree of technological complexity, and scale.

(e) ***SEDO decisions.*** The firm must show that the SEDO critically analyzes information provided by non-SEDOs and uses that analysis to make independent decisions.

(f) ***Delegation.*** A SEDO may delegate administrative activities or operational oversight to a non-SED individual as long as at least one SEDO retains unilateral power to fire the delegate(s), and the chain of command is evident to all participants in the company and to all persons and entities with whom the firm conducts business.

(1) No non-SED participant may have power equal to or greater than that of a SEDO, considering all the circumstances. Aggregate magnitude and significance govern; a numerical tally does not.

(2) Non-SED participants may not make non-routine purchases or disbursements, enter into substantial contracts, or make decisions that affect company viability without the SEDO's consent.

(3) Written provisions or policies that specify the terms under which non-SED participants may sign or act on the SEDO's behalf with respect to recurring matters generally do not violate this paragraph (f), as long as they are consistent with the SEDO having ultimate responsibility for the action.

(g) ***Independent business.***

(1) If the firm receives from or shares personnel, facilities, equipment, financial support, or other essential resources, with another business (whether a DBE or non-DBE firm) or individual on other than commercially reasonable terms, the firm must prove that it would be viable as a going concern without the arrangement.

(2) The firm must not regularly use another firm's business-critical vehicles, equipment, machinery, or facilities to provide a product or service under contract to the same firm or one in a substantially similar business.

(i) ***Exception 1.*** Paragraphs (g)(1) and (2) of this section do not preclude the firm from providing services to a single customer or to a small number of them, provided that the firm is not merely a conduit, captive, or unnecessary third party acting on behalf of another firm or individual. Similarly, providing a volume discount to such a customer does not impair viability unless the firm repeatedly provides the service at a significant and unsustainable loss.

(ii) ***Exception 2.*** A firm may share essential resources and deal exclusively with another firm that a SEDO controls and of which the SEDO owns at least 51 percent ownership.

(h) ***Franchise and license agreements.*** A business operating under a franchise or license agreement may be certified if it meets the standards in this subpart and the franchiser or licenser is not affiliated with the franchisee or licensee. In determining whether affiliation exists, the certifier should generally not consider the restraints relating to standardized quality, advertising, accounting format, and other provisions imposed on the franchisee or licensee by the franchise agreement or license, if the franchisee or licensee has the right to profit from its efforts and bears the risk of loss commensurate with ownership. Alternatively, even though a franchisee or licensee may not be controlled by virtue of such provisions in the franchise agreement or license, affiliation could arise through other means, such as common management or excessive restrictions on the sale or transfer of the franchise interest or license.

[89 FR 24973, Apr. 9, 2024]

§ 26.73 NAICS codes.

(a) A certifier must grant certification to a firm only for specific types of work that the SEDO controls. To become certified in an additional type of work, the firm must demonstrate to the certifier only that its SEDO controls the firm with respect to that type of work. The certifier must not require that the firm be recertified or submit a new application for certification but must verify the SEDO's control of the firm in the additional type of work.

(1) A correct NAICS code is the one that describes, as specifically as possible, the principal goods or services which the firm would provide to DOT recipients. Multiple NAICS codes may be assigned where appropriate. Program participants must rely on, and not depart from, the plain meaning of NAICS code descriptions in determining the scope of a firm's certification.

(2) If there is not a NAICS code that fully, clearly, or sufficiently narrowly describes the type(s) of work for which the firm seeks certification, the certifier must supplement or limit the assigned NAICS code(s) with a clear, specific, and concise narrative description of the type of work in which the firm is certified. A vague, general, or confusing description is insufficient.

(3) Firms and certifiers must check carefully to make sure that the NAICS codes cited in a certification are kept up-to-date and accurately reflect work which the UCP has determined the firm's owners can control. The firm bears the burden of providing detailed company information the certifying agency needs to make an appropriate NAICS code designation.

(4) A certifier may change a certification classification or description if there is a factual basis in the record, in which case it must notify the firm 30 days before making the change. Certifiers may not apply such changes retroactively.

(5) In addition to applying the appropriate NAICS code, the certifier may apply a descriptor from a classification scheme of equivalent detail and specificity. Such a descriptor (*e.g.,* a "work code") does not supersede or limit the types of work for which a DBE is eligible under an appropriate NAICS code.

(b) [Reserved]

[89 FR 24974, Apr. 9, 2024]

Subpart E—Certification Procedures

§ 26.81 Unified Certification Programs.

(a) You and all other DOT recipients in your state must participate in a Unified Certification Program (UCP).

(1) All recipients in the same jurisdiction (normally a State) must sign an agreement establishing a UCP and submit the agreement to the Secretary for approval.

(2) The agreement must provide for the establishment of a UCP meeting all the requirements of this section. The agreement must specify that the UCP will follow all certification procedures and standards of this part, on the same basis as recipients; that the UCP shall cooperate fully with oversight, review, and monitoring activities of DOT and its operating administrations; and that the UCP shall implement DOT directives and guidance concerning certification matters. The agreement shall also commit recipients to ensuring that the UCP has sufficient resources and expertise to carry out the requirements of this part. The agreement shall include an implementation schedule ensuring that the UCP is fully operational no later than 18 months following the approval of the agreement by the Secretary.

(3) Subject to approval by the Secretary, the UCP in each state may take any form acceptable to the recipients in that state.

(4) The Secretary shall review the UCP and approve it, disapprove it, or remand it to the recipients in the state for revisions. A complete agreement which is not disapproved or remanded within 180 days of its receipt is deemed to be accepted.

(b) The UCP shall make all certification decisions on behalf of all DOT recipients in the state with respect to participation in the DOT DBE Program.

(1) Certification decisions by the UCP shall be binding on all DOT recipients within the state.

(2) The UCP shall provide "one-stop shopping" to applicants for certification, such that an applicant is required to apply only once for a DBE certification that will be honored by all recipients in the state.

(3) All obligations of recipients with respect to certification and nondiscrimination must be carried out by UCPs, and recipients may use only UCPs that comply with the certification and nondiscrimination requirements of this part.

(c) All certifications by UCPs shall be pre-certifications; i.e., certifications that have been made final before the due date for bids or offers on a contract on which a firm seeks to participate as a DBE.

(d) A UCP is not required to process an application for certification from a firm having its principal place of business outside the state if the firm is not certified by the UCP in the state in which it maintains its principal place of business. The Jurisdiction of Original Certification UCP shall share its information and documents concerning the firm with other UCPs that are considering the firm's application.

(e) Subject to DOT approval as provided in this section, recipients in two or more states may form a regional UCP. UCPs may also enter into written reciprocity agreements with other UCPs. Such an agreement shall outline the specific responsibilities of each participant. A UCP may accept the certification of any other UCP or DOT recipient.

(f) Pending the establishment of UCPs meeting the requirements of this section, you may enter into agreements with other recipients, on a regional or inter-jurisdictional basis, to perform certification functions required by this part. You may also grant reciprocity to other recipient's certification decisions.

(g) Each UCP must maintain a unified DBE directory containing, for all firms certified by the UCP (including those from other States certified under the provisions of this part), the information required by § 26.31. The UCP must make the directory available to the public electronically, on the internet. The UCP must update the electronic version of the directory by including additions, deletions, and other changes as soon as they are made.

(h) Except as otherwise specified in this section, all provisions of this subpart and subpart D of this part pertaining to recipients also apply to UCPs.

[64 FR 5126, Feb. 2, 1999, as amended at 76 FR 5100, Jan. 28, 2011; 89 FR 24974, Apr. 9, 2024; 89 FR 55089, July 3, 2024]

§ 26.83 What procedures do certifiers follow in making certification decisions?

(a) You must ensure that only firms certified as eligible DBEs under this section participate as DBEs in your program.

(b) You must determine the eligibility of firms as DBEs consistent with the standards of subpart D of this part. When a UCP is formed, the UCP must meet all the requirements of subpart D of this part and this subpart that recipients are required to meet.

(c)

(1) You must take all the following steps in determining whether a DBE firm meets the standards of subpart D of this part:

(i) A certifier must visit the firm's principal place of business, virtually or in person, and interview the SEDO, officers, and key personnel. The certifier must review those persons' résumés and/or work histories. The certifier must maintain a complete audio recording of the interview. The certifier must also visit one or more active job sites (if there is one). These activities comprise the "on-site review" (OSR), a written report of which the certifier must keep in its files.

(ii) Analyze documentation related to the legal structure, ownership, and control of the applicant firm. This includes, but is not limited to, Articles of Incorporation/Organization; corporate by-laws or operating agreements; organizational, annual and board/member meeting records; stock ledgers and certificates; and State-issued Certificates of Good Standing

(iii) Analyze the bonding and financial capacity of the firm; lease and loan agreements; bank account signature cards;

(iv) Determine the work history of the firm, including contracts it has received, work it has completed; and payroll records;

(v) Obtain a statement from the firm of the type of work it prefers to perform as part of the DBE program and its preferred locations for performing the work, if any.

(vi) Obtain or compile a list of the equipment owned by or available to the firm and the licenses the firm and its key personnel possess to perform the work it seeks to do as part of the DBE program;

(vii) Obtain complete Federal income tax returns (or requests for extensions) filed by the firm, its affiliates, and the socially and economically disadvantaged owners for the last 3 years. A complete return includes all forms, schedules, and statements filed with the Internal Revenue Service.

(viii) Require potential DBEs to complete and submit an appropriate application form, except as otherwise provided in § 26.85 of this part.

(2) You must use the application form available at *https://transportation.gov/DBEFORMS* without change or revision. However, you may provide in your DBE program, with the written approval of the concerned operating administration, for supplementing the form by requesting specified additional information not inconsistent with this part.

(3) The certifier must ensure that the SEDO signs the Declaration of Eligibility (DOE) at the end of the Uniform Certification Application (UCA), subscribed to as true under penalty of perjury that all information provided is current, accurate, and complete.

(4) You must review all information on the form prior to making a decision about the eligibility of the firm. You may request clarification of information contained in the application at any time in the application process.

(d) When another certifier, in connection with its consideration of the eligibility of a firm, makes a written request for certification information you have obtained about that firm (e.g., including application materials or the report of a site visit, if you have made one to the firm), you must promptly make the information available to the other certifier.

(e) [Reserved]

(f) Subject to the approval of the concerned operating administration as part of your DBE program, you may impose a reasonable application fee for certification. Fee waivers shall be made in appropriate cases.

(g) You must safeguard from disclosure to unauthorized persons information gathered as part of the certification process that may reasonably be regarded as proprietary or other confidential business information, consistent with applicable Federal, state, and local law.

(h)

(1) Once a certifier has certified a firm, the firm remains certified unless and/or until the certifier removes certification, in whole or in part (*i.e.,* NAICS code removal), through the procedures of § 26.87.

(2) The certifier may not require a DBE to reapply for certification, renew its certification, undergo a recertification, or impose any functionally equivalent requirement. The certifier may, however, conduct a certification review at any reasonable time and/or at regular intervals of at least two years. The certification review may, at the certifier's discretion, include a new OSR. The certifier may also make an unannounced visit to the DBE's offices and/or job site. The certifier may also rely on another certifier's report of its OSR of the DBE.

(i) If you are a DBE, you must inform the certifier or UCP in writing of any change in circumstances affecting your ability to meet size, disadvantaged status, ownership, or control requirements of this part or any material change in the information provided in your application form.

(1) Changes in management responsibility among members of a limited liability company are covered by this requirement.

(2) You must attach supporting documentation describing in detail the nature of such changes.

(3) The DBE must notify the certifier of a material change in its circumstances that affects its continued eligibility within 30 days of its occurrence, explain the change fully, and include a duly executed DOE with the notice. The DBE's non-compliance is a § 26.109(c) failure to cooperate.

(j) A DBE must provide its certifier(s), every year on the anniversary of its original certification, a new DOE along with the specified documentation in § 26.65(a), including gross receipts for its most recently completed fiscal year, calculated on a cash basis regardless of the DBE's overall accounting method. The sufficiency of documentation (and its probative value) may vary by business type, size, history, resources, and overall circumstances. However, the following documents may generally be considered “safe harbors,” provided that they include all reportable receipts, properly calculated, for the full reporting period: audited financial statements, a CPA's signed attestation of correctness and completeness, or all income-related portions of one or more (when there are affiliates) signed Federal income tax returns as filed. Non-compliance, whether full or partial, is a § 26.109(c) failure to cooperate.

(k) The certifier must advise each applicant within 30 days of filing whether the application is complete and suitable for evaluation and, if not, what additional information or action is required.

(l)

(1) The certifier must render a final eligibility decision within 90 days of receiving all information required from the applicant under this part. The certifier may extend this time period once, for no more than an additional 30 days, upon written notice to the firm, explaining fully and specifically the reasons for the extension. On a case-by-case basis, the concerned OA may give the certifier one deadline extension if it approves a written request explaining why the certifier needs more time. The certifier's failure to issue a compliant decision by the applicable deadline is a constructive denial of the application, appealable to DOT under § 26.89. In this case, the certifier may be subject to enforcement actions described in §§ 26.103 and 26.105.

(2) [Reserved]

(m)

(1) A certifier may notify the applicant about ineligibility concerns and allow the firm to rectify deficiencies within the period in paragraph (l) of this section.

(2) If a firm takes curative measures before the certifier renders a decision, the certifier must consider any evidence it submits of having taken such measures. The certifier must not automatically construe curative measures as successful or abusive.

(i) ***Example 1 to paragraph (m)(2).*** The firm may obtain proof of an investment, transaction, or other fact on which its eligibility depends.

(ii) ***Example 2 to paragraph (m)(2).*** An owner or related party may create a legally enforceable document of irrevocable transfer to the SEDO.

(iii) ***Example 3 to paragraph (m)(2).*** The firm may amend an operating agreement, bylaw provision, or other governance document, provided that the amendment accurately reflects the parties' relationships, powers, responsibilities, and other pertinent circumstances.

(n) Except as otherwise provided in this paragraph (n), if an applicant for DBE certification withdraws its application before the certifier issues a decision, the applicant can resubmit the application at any time. However, the certifier may place the reapplication at the "end of the line," behind other applications that have been made since the firm's previous application was withdrawn. The certifier may apply the § 26.86(c) waiting period to a firm that has established a pattern of withdrawing applications before its decision.

[64 FR 5126, Feb. 2, 1999, as amended at 68 FR 35555, June 16, 2003; 76 FR 5100, Jan. 28, 2011; 79 FR 59598, Oct. 2, 2014; 89 FR 24974, Apr. 9, 2024; 89 FR 55090, July 3, 2024]

§ 26.85 Interstate certification.

(a) ***Applicability.*** This section applies to a DBE certified in any UCP.

(b) ***General rule.*** When a DBE applies to another UCP for certification, the new UCP must accept the DBE's certification from its jurisdiction of original certification (JOC). The JOC is the State in which the firm maintains its principal place of business at the time of application unless and until the firm loses certification in that jurisdiction.

(c) ***Application procedure.*** To obtain certification by an additional UCP, the DBE must provide:

(1) A cover letter that specifies that the DBE is applying for interstate certification, identifies all UCPs in which the DBE is certified (including the UCP that originally certified it)

(2) An electronic image of the UCP directory of the original UCP that shows the DBE certification; and

(3) A new DOE.

(d) ***Confirmation of eligibility.*** Within 10 business days of receiving the documents required under paragraph (c) of this section, the additional UCP must confirm the certification of the DBE preferably by reference to the UCP directory of the JOC.

(e) ***Certification.*** If the DBE fulfills the requirements of paragraph (c) of this section and the UCP confirms the DBE's certification per paragraph (d) of this section, the UCP must certify the DBE immediately without undergoing further procedures and provide the DBE with a letter documenting its certification.

(f) ***Noncompliance.*** Failure of the additional UCP to comply with paragraphs (d) and (e) of this section is considered non-compliance with this part.

(g) ***Post-interstate certification proceedings.***

(1) After the additional UCP certifies the DBE, the UCP may request a fully unredacted copy of all, or a portion of, the DBE's certification file from any other UCP in which the DBE is certified.

(2) A UCP must provide a complete unredacted copy of the DBE's certification materials to the additional UCP within 30 days of receiving the request. Confidentiality requirements of §§ 26.83(d) and 26.109(b) do not apply.

(3) Once the new UCP certifies, then it must treat the DBE as it treats other DBEs, for all purposes.

(4) The DBE must provide an annual DOE with documentation of gross receipts, under § 26.83(j), to certifying UCPs on the anniversary date of the DBE's original certification by its JOC.

(h) ***Decertifications.***

(1) If any UCP has reasonable cause to remove a DBE's certification, in whole or in part (*i.e.,* NAICS code removal), it must notify the other UCPs in which the DBE is certified ("other jurisdictions") via email. The notice must explain the UCP's reasons for believing the DBE's certification should be removed.

(2) Within 30 days of receiving the notice, the other jurisdictions must email the UCP contemplating decertification a concurrence or non-concurrence with the proposed action. The other jurisdictions' responses may provide written arguments and evidence and may propose additional reasons to remove certification. A jurisdiction's failure to timely respond to the reasonable cause notice will be deemed to be a concurrence.

(3) After a UCP receives all timely responses, it must make an independent decision whether to issue a NOI and what grounds to include.

(4) Other UCPs may, before the hearing, submit written arguments and evidence concerning whether the firms should remain certified, but may not participate in the hearing.

(5) If the UCP finds the firm ineligible the firm immediately loses certification in all jurisdictions in which it is certified. The NOD must include appeal instructions provided on the Departmental Office of Civil Rights' web page, available at *https://www.transportation.gov/dbeappeal*. The UCP must email a copy of its decision to the other jurisdictions within 3 business days.

(6) The rules of paragraph (h) do not apply to attempts to decertify based upon a DBE's actions or inactions pertaining to §§ 26.83(j) (Declaration of Eligibility) and 26.109(c) (failure to cooperate).

(7) Decertifications under this paragraph (h) must provide due process to DBEs.

(i) If a UCP decides not to issue a NOD removing the DBE's certification, no jurisdiction may initiate decertification proceedings, within one year, on the same or similar grounds and underlying facts.

(ii) If a DBE believes a UCP unfairly targets it with repeated decertification attempts, the DBE may file a complaint to the appropriate OA.

(8) The Department's appeal decisions are binding on all UCPs unless stated otherwise.

[89 FR 24975, Apr. 9, 2024; 89 FR 55090, July 3, 2024]

§ 26.86 Decision letters.

(a) When a certifier denies a firm's request for certification or decertifies the firm, the certifier must provide the firm a NOD explaining the reasons for the adverse decision, specifically referencing the evidence in the record that supports each reason. A certifier must also include, verbatim, the instructions found on the Departmental Office of Civil Rights' web page, available at *https://www.transportation.gov/dbeappeal*.

(b) The certifier must promptly provide the applicant copies of all documents and other information on which it based the denial if the applicant requests them.

(c) The certifier must establish a waiting period for reapplication of no more than 12 months. That period begins to run the day after the date of the decision letter is emailed. After the waiting period expires, the denied firm may reapply to any member of the UCP that denied the application. The certifier must inform the applicant of that right, and specify the date the waiting period ends, in its decision letter.

(d) An appeal does not extend the waiting period.

[89 FR 24976, Apr. 9, 2024]

§ 26.87 Decertification.

(a) ***Burden of proof.*** To decertify a DBE, the certifier bears the burden of proving, by a preponderance of the evidence, that the DBE does not meet the certification standards of this part.

(b) ***Initiation of decertification proceedings.***

(1) A certifier may determine on its own that it has reasonable cause to decertify a DBE.

(2) If an OA determines that there is reasonable cause to believe that a DBE does not meet the eligibility criteria of this part, the OA may direct the certifier to initiate a proceeding to remove the DBE's certification.

(i) The OA must provide the certifier and the DBE written notice describing the reasons for the directive, including any relevant documentation or other information.

(ii) The certifier must immediately commence a proceeding to decertify as provided by paragraph (e) of this section.

(3) Any person may file a complaint explaining, with specificity, why the certifier should decertify a DBE. The certifier need not act on a general allegation or an anonymous complaint. The certifier must keep complainants' identities confidential as provided in § 26.109(b).

(i) The certifier must review its records concerning the DBE, any material the DBE and/or complainant provides, and any other available information. The certifier may request additional information from the DBE or conduct any other investigation that it deems necessary.

(ii) If the certifier determines that there is reasonable cause to decertify the DBE, it initiates a decertification proceeding. If it determines that there is not such reasonable cause, it notifies the complainant and the DBE in writing of its decisions and the reasons for it.

(c) ***Notice of intent (NOI).*** A certifier's first step in any decertification proceeding must be to email a notice of intent (NOI) to the DBE.

(1) The NOI must clearly and succinctly state each reason for the proposed action, and specifically identify the supporting evidence for each reason.

(2) The NOI must notify the DBE of its right to respond in writing, at an informal hearing, or both.

(3) The NOI must inform the DBE of the hearing scheduled on a date no fewer than 30 days and no more than 45 days from the date of the NOI.

(4) If the ground for decertification is that the DBE has been suspended or debarred for conduct related to the DBE program, the certifier issues a NOD decertifying the DBE. In this case, there is no NOI or opportunity for a hearing or written response.

(d) ***Response to NOI.***

(1) If the DBE wants a hearing, it must email the certifier saying so within 10 days of the NOI. If the DBE does not do so, it loses its opportunity for a hearing.

(2) The certifier and DBE may negotiate a different hearing date from that stated in the NOI. Parties must not engage in dilatory tactics.

(3) If the DBE does not want a hearing, or does not give timely notice to the certifier that it wants one, the DBE may still provide written information and arguments to the certifier rebutting the reasons for decertification stated in the NOI.

(e) ***Hearings.***

(1) The purpose of the hearing is for the certifier to present its case and for the DBE to rebut the certifier's allegations.

(2) The hearing is an informal proceeding with rules set by the hearing officer. The SEDO's attorney, a non-SEDO, or other individuals involved with the DBE may attend the hearing and answer questions related to their own experience or more generally about the DBE's ownership, structure and operations.

(3) The certifier must maintain a complete record of the hearing, either in writing, video or audio. If the DBE appeals to DOT under § 26.89, the certifier must provide that record to DOT and to the DBE.

(f) ***Separation of functions.*** The certifier must ensure that the decision in a decertification case is made by an individual who did not take part in actions leading to or seeking to implement the proposal to decertify the DBE and is not subject, with respect to the matter, to direction from the office or personnel who did take part in these actions.

(1) The certifier's method of implementing this requirement must be made part of its DBE program and approved by the appropriate OA.

(2) The decisionmaker must be an individual who is knowledgeable about the certification requirements of this part.

(g) ***Notice of decision.*** The certifier must send the firm a NOD no later than 30 days of the informal hearing and/or receiving written arguments/evidence from the firm in response to the NOI.

(1) The NOD must describe with particularity the reason(s) for the certifier's decision, including specific references to the evidence in the record that supports each reason. The NOD must also inform the firm of the consequences of the decision under paragraph (i) of this section and of its appeal rights under § 26.89.

(2) The certifier must send copies of the NOD to the complainant in an ineligibility complaint or to the OA that directed the certifier to initiate the proceeding.

(3) When sending a copy of an NOD to a complainant other than an OA, the certifier must not include information reasonably construed as confidential business information, unless the certifier has the written consent of the firm that submitted the information.

(4) The certifier must make an entry in DOCR's Online Portal within 5 days of the action. The certifier must enter the name of the firm, names(s) of the firm's owner(s), date of decision, and the reason(s) for its decision.

(h) ***Status of firm during proceeding.*** A DBE remains certified until the certifier issues a NOD.

(i) [Reserved]

(j) ***Consequences.*** Decertification has the following effects on contract and overall goals and DBE participation:

(1) When a prime contractor has made a commitment to use a DBE, but a subcontract has not been executed before the certifier issues the NOD as provided for in paragraph (g) of this section, the committed firm does not count toward the contract goal. The recipient must direct the prime contractor to meet the contract goal with an eligible DBE or demonstrate to the recipient that it has made good faith efforts to do so.

(2) When the recipient has made a commitment to using a DBE prime contractor, but a contract has not been executed before the certifier issues the NOD, the decertified firm does not count toward the recipient's overall DBE goal.

(3) If a prime contractor has executed a subcontract with a DBE before the certifier issues the NOD, the prime contractor may continue to receive credit toward the contract goal for the firm's work. In this case, however, the prime contractor may not extend or add work to the contract without prior written consent from the recipient.

(4) If a prime contractor has executed a subcontract with a DBE before the certifier issues the NOD, the prime contractor may continue to receive credit toward the contract goal as set forth in paragraph (j)(3) of this section; however, the portion of the decertified firm's continued performance of the contract must not count toward the recipient's overall goal.

(5) If the recipient executed a prime contract with a DBE that was later decertified, the portion of the decertified firm's performance of the contract remaining after the certifier issued the NOD must not count toward an overall goal, but the DBE's performance of the contract may continue to count toward satisfying any contract goal.

(6) The following exceptions apply to this paragraph (j):

(i) If a certifier decertifies a firm solely because it exceeds the business size standard during the performance of the contract, the recipient may continue to count the portion of the decertified firm's performance of the contract remaining after the certifier issued the NOD toward the recipient's overall goal as well as toward the contract goal.

(ii) If the certifier decertifies the DBE because it was acquired by or merged with a non-DBE, the recipient may not continue to count the portion of the decertified firm's performance on the contract remaining, after the certifier issued a NOD, toward either the contract goal or the overall goal, even if a prime contractor has executed a subcontract with the firm or the recipient has executed a prime contract with the DBE that was later decertified. In this case, if eliminating the credit of the decertified firm will affect the prime contractor's ability to meet the contract goal, the recipient must direct the prime contractor to subcontract to an eligible DBE to the extent needed to meet the contract goal or demonstrate to the recipient that it has made good faith efforts to do so.

[89 FR 24976, Apr. 9, 2024; 89 FR 55090, July 3, 2024]

§ 26.88 Summary suspension of certification.

(a) ***Definition.*** Summary suspension is an extraordinary remedy for lapses in compliance that cannot reasonably or adequately be resolved in a timely manner by other means.

(1) A firm's certification is suspended under this part as soon as the certifier transmits electronic notice to its owner at the last known email address.

(2) During the suspension period, the DBE may not be considered to meet a contract or participation goal on contracts executed during the suspension period.

(b) ***Mandatory and elective suspensions*** —

(1) ***Mandatory.*** The certifier must summarily suspend a DBE's certification when:

(i) The certifier has clear and credible evidence of the DBE's or its SEDO's involvement in fraud or other serious criminal activity.

(ii) The OA with oversight so directs.

(2) ***Elective.***

(i) The certifier has discretion to suspend summarily if it has clear and credible evidence that the DBE's continued certification poses a substantial threat to program integrity.

(ii) An owner upon whom the firm relies for eligibility does not timely file the declaration and gross receipts documentation that § 26.83(j) requires.

(c) ***Coordination with other remedies.*** In most cases, a simple information request or a § 26.87 NOI is a sufficient response to events described in paragraphs (b)(1) and (2) of this section. The certifier should consider the burden to the DBE and to itself in determining whether summary suspension is a more prudent and proportionate, effective response. The certifier may *elect* to suspend the same DBE just once in any 12-month period.

(d) ***Procedures*** —

(1) ***Notice.*** The certifier must notify the firm, by email, of its summary suspension notice (SSN) on a business day during regular business hours. The SSN must explain the action, the reason for it, the consequences, and the evidence on which the certifier relies.

(i) Elective SSNs may not cite more than one reason for the action.

(ii) Mandatory SSNs may state multiple reasons.

(iii) The SSN, regardless of type, must demand that the DBE show cause why it should remain certified and provide the time and date of a virtual show-cause hearing at which the firm may present information and arguments concerning why the certifier should lift the suspension. The SSN must also advise that the DBE may provide written information and arguments in lieu of or in addition to attending the hearing.

(2) ***Hearing.*** The hearing date must be a business day that is at least 15 but not more than 25 days after the date of the notice. The DBE may respond in writing in lieu of or in addition to attending the hearing; however, it will have waived its right to a hearing if it does not confirm its attendance within 10 days of the notice and will have forfeited its certification if it does not acknowledge the notice within 15 days. The show-cause hearing must be conducted as a video conference on a standard commercial platform that the DBE may readily access at no cost.

(3) ***Response.*** The DBE may provide information and arguments concerning its continuing eligibility until the 15th day following the suspension notice or the day of the hearing, if any, whichever is later. The DBE must email any written response it provides. Email submissions correctly addressed are effective when sent. The certifier may permit additional submissions after the hearing, as long as the extension ends on a business day that is not more than 30 days after the notice.

(4) ***Scope and burdens.***

(i) Suspension proceedings are limited to the suspension ground specified in the notice.

(ii) The certifier may not amend its reason(s) for summarily suspending certification, nor may it electively suspend the firm again during the 12-month period following the notice.

(iii) The DBE has the burden of producing information and/or making arguments concerning its continued eligibility, but it need only contest the reason cited.

(iv) The certifier has the burden of proving its case by a preponderance of the evidence. It must issue an NOD within 30 days of the suspension notice or lift the suspension. Any NOD must rely only on the reason given in the summary suspension notice.

(v) The DBE's failure to provide information contesting the suspension does not impair the certifier's ability to prove its case. That is, the uncontested evidence upon which the certifier relies in its notice, if substantial, will constitute a preponderance of the evidence for purposes of the NOD.

(5) ***Duration.*** The DBE remains suspended during the proceedings described in this section but in no case for more than 30 days. If the certifier has not lifted the suspension or provided a rule-compliant NOD by 4:30 p.m. on the 30th day, then it must lift the suspension and amend applicable DBE lists and databases by 12 p.m. the following business day.

(e) ***Recourse*** —

(1) ***Appeal.*** The DBE may appeal a final decision under paragraph (d)(4)(iv) of this section, as provided in § 26.89(a), but may *not* appeal the suspension itself, unless paragraph (e)(2) of this section applies.

(2) ***Enforcement.***

(i) The DBE may immediately petition the Department for an order to vacate a certifier's action if:

(A) The certifier sends a second elective SSN within 12 months, or

(B) Cites multiple reasons in an elective SSN contrary to paragraph (d)(1)(i) of this section.

(ii) The DBE may also petition to the Department for an order to compel if the certifier fails to act within the time specified in paragraph (d)(5) of this section.

(3) In either case, the DBE must:

(i) Email the request under the subject line, “REQUEST FOR ENFORCEMENT ORDER” in all caps;

(ii) Limit the request to a one-page explanation that includes:

(A) The certifier's name and the suspension dates;

(B) Contact information for the certifier, the DBE, and the DBE's SEDO(s); and

(C) The general nature and date of the firm's response, if any, to the second suspension notice; and

(D) The suspension notice(s).

[89 FR 24977, Apr. 9, 2024; 89 FR 55090, July 3, 2024]

§ 26.89 Appeals to the Department.

(a)

(1) Applicants and decertified firms may appeal adverse NODs to the Department.

(2) An ineligibility complainant or applicable Operating Administration (the latter by the terms of § 26.87(c)) may appeal to the Department if the certifier does not find reasonable cause to issue an NOI to decertify or affirmatively determines that the DBE remains eligible.

(3) Appellants must email appeals as directed in the certifier's decision letter within 45 days of the date of the letter. The appeal must at a minimum include a narrative that explains fully and specifically why the firm believes the decision is in error, what outcome-determinative facts the certifier did not consider, and/or what part 26 provisions the certifier misapplied.

(4) The certifier's decision remains in effect until the Department resolves the appeal or the certifier reverses itself.

(b) When it receives an appeal, the Department requests a copy of the certifier's complete administrative record including a video, audio, or transcript of any hearing, which the certifier must provide within 20 days of the Department's request. The Department may extend this time period when the certifier demonstrates good cause. The certifier must ensure that the administrative record is well organized, indexed, and paginated and the certifier must provide the appellant a copy of any supplemental information it provides to DOT.

(c)

(1) The Department may accept an untimely or incomplete appeal if it determines, in its sole discretion, that doing so is in the interest of justice.

(2) The Department may dismiss non-compliant or frivolous appeals without further proceedings.

(d) The Department will avail itself of whatever remedies for noncompliance it considers appropriate.

(e) The Department decides only the issue(s) presented on appeal. It does not conduct a *de novo* review of the matter, assess all eligibility requirements, or hold hearings. It considers the administrative record and any additional information that it considers relevant.

(f)

(1) The Department affirms the certifier's decision if it determines that the decision is consistent with applicable rules and supported by substantial evidence.

(2) The Department reverses decisions that do not meet the standard in paragraph (f)(1) of this section.

(3) The Department need not reverse if an error or omission did not result in fundamental unfairness or undue prejudice.

(4) The Department may remand the case with instructions for further action. When the Department specifies further actions, the certifier must take them without delay.

(5) The Department generally does not uphold the certifier's decision based on grounds not specified in its decision.

(6) The Department resolves appeals on the basis of facts demonstrated, and evidence presented, at the time of the certifier's decision.

(7) The Department may summarily dismiss an appeal. Reasons for doing so include, but are not limited to, non-compliance, abuse of process, appellant or certifier request, and failure to state a claim upon which relief can be granted.

(g) The Department does not issue advisory opinions.

(h) All decisions described in paragraph (f) of this section are administratively final unless they say otherwise.

(i) DOCR posts final decisions to its website, available at *https://www.transportation.gov/DBEDecisions*.

[89 FR 24978, Apr. 9, 2024]

§ 26.91 What actions do certifiers take following DOT certification appeal decisions?

(a) If you are the certifier from whose action an appeal under § 26.89 is taken, the decision is binding. It is not binding on other certifiers.

(b) If you are a certifier to which a DOT determination under § 26.89 is applicable, you must take the following action:

(1) If the Department determines that you erroneously certified a firm, you must remove the firm's eligibility on receipt of the determination, without further proceedings on your part. Effective on the date of your receipt of the Department's determination, the consequences of a removal of eligibility set forth in § 26.87(j) take effect.

(2) If the Department determines that you erroneously failed to find reasonable cause to remove the firm's eligibility, you must expeditiously commence a proceeding to determine whether the firm's eligibility should be removed, as provided in § 26.87.

(3) If the Department determines that you erroneously declined to certify or removed the eligibility of the firm, you must certify the firm, effective on the date of your receipt of the written notice of Department's determination.

(4) If the Department determines that you erroneously determined that the presumption of social and economic disadvantage either should or should not be deemed rebutted, you must take appropriate corrective action as determined by the Department.

(5) If the Department affirms your determination, no further action is necessary.

(c) Where DOT has upheld your denial of certification to or removal of eligibility from a firm, or directed the removal of a firm's eligibility, other certifiers with whom the firm is certified may commence a proceeding to remove the firm's eligibility under § 26.87. Such certifiers must not remove the firm's eligibility absent such a proceeding. Where DOT has reversed your denial of certification to or removal of eligibility from a firm, other certifiers must take the DOT action into account in any certification action involving the firm. However, other certifiers are not required to certify the firm based on the DOT decision.

[64 FR 5126, Feb. 2, 1999, as amended at 89 FR 24979, Apr. 9, 2024]

Subpart F—Compliance and Enforcement

§ 26.101 What compliance procedures apply to recipients?

(a) If you fail to comply with any requirement of this part, you may be subject to formal enforcement action under § 26.103 or § 26.105 or appropriate program sanctions by the concerned operating administration, such as the suspension or termination of Federal funds, or refusal to approve projects, grants or contracts until deficiencies are remedied. Program sanctions may include, in the case of the FHWA program, actions provided for under 23 CFR 1.36; in the case of the FAA program, actions consistent with 49 U.S.C. 47106(d), 47111(d), and 47122; and in the case of the FTA program, any actions permitted under 49 U.S.C. chapter 53 or applicable FTA program requirements.

(b) As provided in statute, you will not be subject to compliance actions or sanctions for failing to carry out any requirement of this part because you have been prevented from complying because a Federal court has issued a final order in which the court found that the requirement is unconstitutional.

§ 26.103 What enforcement actions apply in FHWA and FTA programs?

The provisions of this section apply to enforcement actions under FHWA and FTA programs:

(a) ***Noncompliance complaints.*** Any person who believes that a recipient has failed to comply with its obligations under this part may file a written complaint with the concerned operating administration's Office of Civil Rights. If you want to file a complaint, you must do so no later than 180 days after the date of the alleged violation or the date on which you learned of a continuing course of conduct in violation of this part. In response to your written request, the Office of Civil Rights may extend the time for filing in the interest of justice, specifying in writing the reason for so doing. The Office of Civil Rights may protect the confidentiality of your identity as provided in § 26.109(b). Complaints under this part are limited to allegations of violation of the provisions of this part.

(b) ***Compliance reviews.*** The concerned operating administration may review the recipient's compliance with this part at any time, including reviews of paperwork and on-site reviews, as appropriate. The Office of Civil Rights may direct the operating administration to initiate a compliance review based on complaints received.

(c) ***Reasonable cause notice.*** If it appears, from the investigation of a complaint or the results of a compliance review, that you, as a recipient, are in noncompliance with this part, the appropriate DOT office promptly sends you, return receipt requested, a written notice advising you that there is reasonable cause to find you in noncompliance. The notice states the reasons for this finding and directs you to reply within 30 days concerning whether you wish to begin conciliation.

(d) ***Conciliation.***

(1) If you request conciliation, the appropriate DOT office shall pursue conciliation for at least 30, but not more than 120, days from the date of your request. The appropriate DOT office may extend the conciliation period for up to 30 days for good cause, consistent with applicable statutes.

(2) If you and the appropriate DOT office sign a conciliation agreement, then the matter is regarded as closed and you are regarded as complying. The conciliation agreement sets forth the measures you have taken or will take to ensure compliance. While a conciliation agreement is in effect, you remain eligible for FHWA or FTA financial assistance.

(3) The concerned operating administration shall monitor your implementation of the conciliation agreement and ensure that its terms are complied with. If you fail to carry out the terms of a conciliation agreement, you are in noncompliance.

(4) If you do not request conciliation, or a conciliation agreement is not signed within the time provided in paragraph (d)(1) of this section, then enforcement proceedings begin.

(e) ***Enforcement actions.***

(1) Enforcement actions are taken as provided in this subpart.

(2) Applicable findings in enforcement proceedings are binding on all DOT offices.

[64 FR 5126, Feb. 2, 1999, as amended at 89 FR 24979, Apr. 9, 2024]

§ 26.105 What enforcement actions apply in FAA programs?

(a) Compliance with all requirements of this part by airport sponsors and other recipients of FAA financial assistance is enforced through the procedures of Title 49 of the United States Code, including 49 U.S.C. 47106(d), 47111(d), and 47122, and regulations implementing them.

(b) The provisions of § 26.103(b) and this section apply to enforcement actions in FAA programs.

(c) Any person who knows of a violation of this part by a recipient of FAA funds may file a complaint under 14 CFR part 16 with the Federal Aviation Administration Office of Chief Counsel.

§ 26.107 What enforcement actions apply to firms participating in the DBE program?

(a) If you are a firm that does not meet the eligibility criteria of subpart D of this part and that attempts to participate in a DOT-assisted program as a DBE on the basis of false, fraudulent, or deceitful statements or representations or under circumstances indicating a serious lack of business integrity or honesty, the Department may initiate suspension or debarment proceedings against you under 2 CFR parts 180 and 1200.

(b) If you are a firm that, in order to meet DBE contract goals or other DBE program requirements, uses or attempts to use, on the basis of false, fraudulent or deceitful statements or representations or under circumstances indicating a serious lack of business integrity or honesty, another firm that does not meet the eligibility criteria of subpart D of this part, the Department may initiate suspension or debarment proceedings against you under 2 CFR parts 180 and 1200.

(c) In a suspension or debarment proceeding brought under paragraph (a) or (b) of this section, the concerned operating administration may consider the fact that a purported DBE has been certified by a recipient. Such certification does not preclude the Department from determining that the purported DBE, or another firm that has used or attempted to use it to meet DBE goals, should be suspended or debarred.

(d) The Department may take enforcement action under 49 CFR Part 31, Program Fraud and Civil Remedies, against any participant in the DBE program whose conduct is subject to such action under 49 CFR part 31.

(e) The Department may refer to the Department of Justice, for prosecution under 18 U.S.C. 1001 or other applicable provisions of law, any person who makes a false or fraudulent statement in connection with participation of a DBE in any DOT-assisted program or otherwise violates applicable Federal statutes.

[64 FR 5126, Feb. 2, 1999, as amended at 76 FR 5101, Jan. 28, 2011]

§ 26.109 What are the rules governing information, confidentiality, cooperation, and intimidation or retaliation?

(a) ***Availability of records.***

(1) In responding to requests for information concerning any aspect of the DBE program, the Department complies with provisions of the Federal Freedom of Information and Privacy Acts (5 U.S.C. 552 and 552a). The Department may make available to the public any information concerning the DBE program release of which is not prohibited by Federal law.

(2) Notwithstanding any provision of Federal or state law, you must not release any information that may reasonably be construed as confidential business information to any third party without the written consent of the firm that submitted the information. This includes applications for DBE certification and supporting information. However, you must transmit this information to DOT in any certification appeal proceeding under § 26.89 of this part or to any other state to which the individual's firm has applied for certification under § 26.85 of this part.

(b) ***Confidentiality of information on complainants.*** Notwithstanding the provisions of paragraph (a) of this section, the identity of complainants shall be kept confidential, at their election. If such confidentiality will hinder the investigation, proceeding or hearing, or result in a denial of appropriate administrative due process to other parties, the complainant must be advised for the purpose of waiving the privilege. Complainants are advised that, in some circumstances, failure to waive the privilege may result in the closure of the investigation or dismissal of the proceeding or hearing. FAA follows the procedures of 14 CFR part 16 with respect to confidentiality of information in complaints.

(c) ***Cooperation.*** All participants in the Department's DBE program (including, but not limited to, recipients, DBE firms and applicants for DBE certification, complainants and appellants, and contractors using DBE firms to meet contract goals) are required to cooperate fully and promptly with DOT and recipient compliance reviews, certification reviews, investigations, and other requests for information. Failure to do so shall be a ground for appropriate action against the party involved (e.g., with respect to recipients, a

finding of noncompliance; with respect to DBE firms, denial of certification or removal of eligibility and/or suspension and debarment; with respect to a complainant or appellant, dismissal of the complaint or appeal; with respect to a contractor which uses DBE firms to meet goals, findings of non-responsibility for future contracts and/or suspension and debarment).

(d) ***Intimidation and retaliation.*** If you are a recipient, contractor, or any other participant in the program, you must not intimidate, threaten, coerce, or discriminate against any individual or firm for the purpose of interfering with any right or privilege secured by this part or because the individual or firm has made a complaint, testified, assisted, or participated in any manner in an investigation, proceeding, or hearing under this part. If you violate this prohibition, you are in noncompliance with this part.

[64 FR 5126, Feb. 2, 1999, as amended at 68 FR 35556, June 16, 2003; 76 FR 5101, Jan. 28, 2011]

§ 26.111 DBE reevaluation process.

(a) Effective October 3, 2025, each UCP must:

(1) Identify each currently certified DBE;

(2) Provide each firm identified pursuant to subparagraph (a)(1) with the opportunity to submit documentation demonstrating its DBE eligibility under the standards set forth in this part;

(3) Determine whether each firm identified pursuant to subparagraph (a)(1) meets the DBE eligibility standards set forth in this part; and

(4) Issue a written decision to each firm reevaluated pursuant to subparagraph (a)(3), indicating that it has either been recertified or is decertified.

(b) The provisions of § 26.87 of this part shall not apply to any action taken pursuant to paragraph (a).

(c) Each UCP must reevaluate each firm identified pursuant to subparagraph (a)(1) as quickly as practicable and must promptly notify the Department when it has done so. The Department reserves the right to review a UCP's reevaluation process.

[90 FR 47982, Oct. 3, 2025]

Appendix A to Part 26—Guidance Concerning Good Faith Efforts

I. When, as a recipient, you establish a contract goal on a DOT-assisted contract for procuring construction, equipment, services, or any other purpose, a bidder must, in order to be responsible and/or responsive, make sufficient good faith efforts to meet the goal. The bidder can meet this requirement in either of two ways. First, the bidder can meet the goal, documenting commitments for participation by DBE firms sufficient for this purpose. Second, even if it doesn't meet the goal, the bidder can document adequate good faith efforts. This means that the bidder must show that it took all necessary and reasonable steps to achieve a DBE goal or other requirement of this part which, by their scope, intensity, and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if they were not fully successful.

II. In any situation in which you have established a contract goal, Part 26 requires you to use the good faith efforts mechanism of this part. As a recipient, you have the responsibility to make a fair and reasonable judgment whether a bidder that did not meet the goal made adequate good faith efforts. It is important for you to consider the quality, quantity, and intensity of the different kinds of efforts that the bidder has made, based on the regulations and the guidance in this Appendix.

The efforts employed by the bidder should be those that one could reasonably expect a bidder to take if the bidder were actively and aggressively trying to obtain DBE participation sufficient to meet the DBE contract goal. Mere pro forma efforts are not good faith efforts to meet the DBE contract requirements. We emphasize, however, that your determination concerning the sufficiency of the firm's good faith efforts is a judgment call. Determinations should not be made using quantitative formulas.

III. The Department also strongly cautions you against requiring that a bidder meet a contract goal (*i.e.*, obtain a specified amount of DBE participation) in order to be awarded a contract, even though the bidder makes an adequate good faith efforts showing. This rule specifically prohibits you from ignoring bona fide good faith efforts.

IV. The following is a list of types of actions which you should consider as part of the bidder's good faith efforts to obtain DBE participation. It is not intended to be a mandatory checklist, nor is it intended to be exclusive or exhaustive. Other factors or types of efforts may be relevant in appropriate cases.

A.

(1) Conducting market research to identify small business contractors and suppliers and soliciting through all reasonable and available means the interest of all certified DBEs that have the capability to perform the work of the contract. This may include attendance at pre-bid and business matchmaking meetings and events, advertising and/or written notices, posting of Notices of Sources Sought and/or Requests for Proposals, written notices or emails to all DBEs listed in the State's directory of transportation firms that specialize in the areas of work desired (as noted in the DBE directory) and which are located in the area or surrounding areas of the project.

(2) The bidder should solicit this interest as early in the acquisition process as practicable to allow the DBEs to respond to the solicitation and submit a timely offer for the subcontract. The bidder should determine with certainty if the DBEs are interested by taking appropriate steps to follow up initial solicitations.

B. Selecting portions of the work to be performed by DBEs in order to increase the likelihood that the DBE goals will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units (for example, smaller tasks or quantities) to facilitate DBE participation, even when the prime contractor might otherwise prefer to perform these work items with its own forces. This may include, where possible, establishing flexible timeframes for performance and delivery schedules in a manner that encourages and facilitates DBE participation.

C. Providing interested DBEs with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation with their offer for the subcontract.

D.

(1) Negotiating in good faith with interested DBEs. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBEs that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional Agreements could not be reached for DBEs to perform the work.

(2) A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBEs is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also, the ability or desire of a prime contractor to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Prime contractors are not, however, required to accept higher quotes from DBEs if the price difference is excessive or unreasonable.

E.

(1) Not rejecting DBEs as being unqualified without sound reasons based on a thorough investigation of their capabilities. The contractor's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union status) are not legitimate causes for the rejection or non-solicitation of bids in the contractor's efforts to meet the project goal. Another practice considered an insufficient good faith effort is the rejection of the DBE because its quotation for the work was not the lowest received. However, nothing in this paragraph shall be construed to require the bidder or prime contractor to accept unreasonable quotes in order to satisfy contract goals.

(2) A prime contractor's inability to find a replacement DBE at the original price is not alone sufficient to support a finding that good faith efforts have been made to replace the original DBE. The fact that the contractor has the ability and/or desire to perform the contract work with its own forces does not relieve the contractor of the obligation to make good faith efforts to find a replacement DBE, and it is not a sound basis for rejecting a prospective replacement DBE's reasonable quote.

F. Making efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance as required by the recipient or contractor.

G. Making efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services.

H. Effectively using the services of available minority/women community organizations; minority/women contractors' groups; local, State, and Federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBEs.

V. In determining whether a bidder has made good faith efforts, it is essential to scrutinize its documented efforts. At a minimum, you must review the performance of other bidders in meeting the contract goal. For example, when the apparent successful bidder fails to meet the contract goal, but others meet it, you may reasonably raise the question of whether, with additional efforts, the apparent successful bidder could have met the goal. If the apparent successful bidder fails to meet the goal, but meets or exceeds

the average DBE participation obtained by other bidders, you may view this, in conjunction with other factors, as evidence of the apparent successful bidder having made good faith efforts. As provided in § 26.53(b)(2)((vi), you must also require the contractor to submit copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract to review whether DBE prices were substantially higher; and contact the DBEs listed on a contractor's solicitation to inquire as to whether they were contacted by the prime. Pro forma mailings to DBEs requesting bids are not alone sufficient to satisfy good faith efforts under the rule.

VI. A promise to use DBEs after contract award is not considered to be responsive to the contract solicitation or to constitute good faith efforts except in design-build procurement.

[79 FR 59600, Oct. 2, 2014, as amended at 89 FR 24979, Apr. 9, 2024]

Appendix B to Part 26 [Reserved]

Appendix C to Part 26—DBE Business Development Program Guidelines

The purpose of this program element is to further the development of DBEs, including but not limited to assisting them to move into non-traditional areas of work and/or compete in the marketplace outside the DBE program, via the provision of training and assistance from the recipient.

(A) Each firm that participates in a recipient's business development program (BDP) program is subject to a program term determined by the recipient. The term should consist of two stages; a developmental stage and a transitional stage.

(B) In order for a firm to remain eligible for program participation, it must continue to meet all eligibility criteria contained in part 26.

(C) By no later than 6 months of program entry, the participant should develop and submit to the recipient a comprehensive business plan setting forth the participant's business targets, objectives and goals. The participant will not be eligible for program benefits until such business plan is submitted and approved by the recipient. The approved business plan will constitute the participant's short and long term goals and the strategy for developmental growth to the point of economic viability in non-traditional areas of work and/or work outside the DBE program.

(D) The business plan should contain at least the following:

(1) An analysis of market potential, competitive environment and other business analyses estimating the program participant's prospects for profitable operation during the term of program participation and after graduation from the program.

(2) An analysis of the firm's strengths and weaknesses, with particular attention paid to the means of correcting any financial, managerial, technical, or labor conditions which could impede the participant from receiving contracts other than those in traditional areas of DBE participation.

(3) Specific targets, objectives, and goals for the business development of the participant during the next two years, utilizing the results of the analysis conducted pursuant to paragraphs (C) and (D)(1) of this appendix;

(4) Estimates of contract awards from the DBE program and from other sources which are needed to meet the objectives and goals for the years covered by the business plan; and

(5) Such other information as the recipient may require.

(E) Each participant should annually review its currently approved business plan with the recipient and modify the plan as may be appropriate to account for any changes in the firm's structure and redefined needs. The currently approved plan should be considered the applicable plan for all program purposes until the recipient approves in writing a modified plan. The recipient should establish an anniversary date for review of the participant's business plan and contract forecasts.

(F) Each participant should annually forecast in writing its need for contract awards for the next program year and the succeeding program year during the review of its business plan conducted under paragraph (E) of this appendix. Such forecast should be included in the participant's business plan. The forecast should include:

(1) The aggregate dollar value of contracts to be sought under the DBE program, reflecting compliance with the business plan;

(2) The aggregate dollar value of contracts to be sought in areas other than traditional areas of DBE participation;

(3) The types of contract opportunities being sought, based on the firm's primary line of business; and

(4) Such other information as may be requested by the recipient to aid in providing effective business development assistance to the participant.

(G) Program participation is divided into two stages;

(1) a developmental stage and

(2) a transitional stage. The developmental stage is designed to assist participants to overcome their social and economic disadvantage by providing such assistance as may be necessary and appropriate to enable them to access relevant markets and strengthen their financial and managerial skills. The transitional stage of program participation follows the developmental stage and is designed to assist participants to overcome, insofar as practical, their social and economic disadvantage and to prepare the participant for leaving the program.

(H) The length of service in the program term should not be a pre-set time frame for either the developmental or transitional stages but should be figured on the number of years considered necessary in normal progression of achieving the firm's established goals and objectives. The setting of such time could be factored on such items as, but not limited to, the number of contracts, aggregate amount of the contract received, years in business, growth potential, etc.

(I) Beginning in the first year of the transitional stage of program participation, each participant should annually submit for inclusion in its business plan a transition management plan outlining specific steps to promote profitable business operations in areas other than traditional areas of DBE participation after graduation from the program. The transition management plan should be submitted to the recipient at the same time other modifications are submitted pursuant to the annual review under paragraph (E) of this section. The plan should set forth the same information as required under paragraph (F) of steps the participant will take to continue its business development after the expiration of its program term.

(J) When a participant is recognized as successfully completing the program by substantially achieving the targets, objectives and goals set forth in its program term, and has demonstrated the ability to compete in the marketplace, its further participation within the program may be determined by the recipient.

(K) In determining whether a concern has substantially achieved the goals and objectives of its business plan, the following factors, among others, should be considered by the recipient:

(1) Profitability;

(2) Sales, including improved ratio of non-traditional contracts to traditional-type contracts;

(3) Net worth, financial ratios, working capital, capitalization, access to credit and capital;

(4) Ability to obtain bonding;

(5) A positive comparison of the DBE's business and financial profile with profiles of non-DBE businesses in the same area or similar business category; and

(6) Good management capacity and capability.

(L) Upon determination by the recipient that the participant should be graduated from the developmental program, the recipient should notify the participant in writing of its intent to graduate the firm in a letter of notification. The letter of notification should set forth findings, based on the facts, for every material issue relating to the basis of the program graduation with specific reasons for each finding. The letter of notification should also provide the participant 45 days from the date of service of the letter to submit in writing information that would explain why the proposed basis of graduation is not warranted.

(M) Participation of a DBE firm in the program may be discontinued by the recipient prior to expiration of the firm's program term for good cause due to the failure of the firm to engage in business practices that will promote its competitiveness within a reasonable period of time as evidenced by, among other indicators, a pattern of inadequate performance or unjustified delinquent performance. Also, the recipient can discontinue the participation of a firm that does not actively pursue and bid on contracts, and a firm that, without justification, regularly fails to respond to solicitations in the type of work it is qualified for and in the geographical areas where it has indicated availability under its approved business plan. The recipient should take such action if over a 2-year period a DBE firm exhibits such a pattern.

Appendix D to Part 26—Mentor-Protégé Program Guidelines

(A) The purpose of this program element is to further the development of DBEs, including but not limited to assisting them to move into non-traditional areas of work and/or compete in the marketplace outside the DBE program, via the provision of training and assistance from other firms. To operate a mentor-protégé program, a recipient must obtain the approval of the concerned operating administration.

(B)

(1) Any mentor-protégé relationship shall be based on a written development plan, approved by the recipient, which clearly sets forth the objectives of the parties and their respective roles, the duration of the arrangement and the services and resources to be provided by the mentor to the protégé. The formal mentor-protégé agreement may set a fee schedule to cover the direct and indirect cost for such services rendered by the mentor for specific training and assistance to the protégé through the life of the agreement. Services provided by the mentor may be reimbursable under the FTA, FHWA, and FAA programs.

(2) To be eligible for reimbursement, the mentor's services provided and associated costs must be directly attributable and properly allowable to specific individual contracts. The recipient may establish a line item for the mentor to quote the portion of the fee schedule expected to be provided during the life of the contract. The amount claimed shall be verified by the recipient and paid on an incremental basis representing the time the protégé is working on the contract. The total individual contract figures accumulated over the life of the agreement shall not exceed the amount stipulated in the original mentor/protégé agreement.

(C) DBEs involved in a mentor-protégé agreement must be independent business entities which meet the requirements for certification as defined in subpart D of this part. A protégé firm must be certified *before* it begins participation in a mentor-protégé arrangement. If the recipient chooses to recognize mentor/ protégé agreements, it should establish formal general program guidelines. These guidelines must be submitted to the operating administration for approval prior to the recipient executing an individual contractor/ subcontractor mentor-protégé agreement.

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DAVIS BACON WAGE RATES

STATE: NEW HAMPSHIRE

ROCKINGHAM COUNTY

GENERAL DECISION NUMBER: NH20260022 05/18/2026

CONSTRUCTION TYPES: BUILDING

"General Decision Number: NH20260022 05/18/2026

State: New Hampshire

Construction Types: Building

Counties: New Hampshire Counties of Rockingham

Modification Number	Publication Date
0	01/02/2026
1	05/18/2026

	Rates	Fringes
ASBE0006-014 09/01/2024		
ASBESTOS WORKER/HEAT & FROST INSULATOR	$44.36	$36.63
BOIL0029-004 01/01/2025		
BOILERMAKER	$42.83	$25.29
BRNH0003-001 05/01/2025		
BRICKLAYER.	$43.91	$28.47
ELEC0490-006 01/01/2025		
ELECTRICIAN (INCLUDES LOW VOLTAGE WIRING AND ALARM INSTALLATION)	$36.12	$22.92
ELEV0004-007 01/01/2025		
ELEVATOR MECHANIC	$74.17	$38.44

A. PAID HOLIDAYS: NEW YEAR'S DAY, MEMORIAL DAY, INDEPENDENCE DAY, LABOR DAY, VETERANS' DAY, THANKSGIVING DAY, CHRISTMAS DAY AND THE FRIDAY AFTER THANKSGIVING.

B. VACATION: EMPLOYER CONTRIBUTES 8% OF BASIC HOURLY RATE FOR 5 YEARS OR MORE OF SERVICE; 6% OF BASIC HOURLY RATE FOR 6 MONTHS TO 5 YEARS OF SERVICE AS VACATION PAY CREDIT

	Rates	Fringes
IRON0007-037 09/16/2025		
IRONWORKER (REINFORCING AND STRUCTURAL)	$33.65	$26.12
LABO0976-008 12/01/2023		
LABORER: COMMON OR GENERAL	$25.40	$21.43
PLUM0131-004 06/01/2025		
PIPEFITTER	$45.76	$26.19
SUNH2015-008 06/16/2017		
WATERPROOFER	$26.69	$0.00
SPRINKLER FITTER (FIRE SPRINKLERS)	$31.29	$9.78
SHEET METAL WORKER, INCLUDES HVAC DUCT INSTALLATION	$24.88	$5.46
ROOFER	$19.22	$0.00
PLUMBER, INCLUDES HVAC PIPE INSTALLATION	$26.72	$5.56
PAINTER: SPRAY	$22.99	$3.28
PAINTER (BRUSH AND ROLLER)	$18.10	$1.58
OPERATOR: ROLLER	$23.56	$3.28
OPERATOR: LOADER	$22.25	$2.13
OPERATOR: CRANE	$27.42	$3.83
OPERATOR: BACKHOE/EXCAVATOR/TRACKHOE	$24.02	$4.25
LABORER: MASON TENDER – BRICK	$16.52	$4.74
GLAZIER	$26.75	$3.48
DRYWALL HANGER, INCLUDES METAL STUD INSTALLATION	$25.00	$0.00
DRYWALL FINISHER/TAPER	$25.00	$0.00
CEMENT MASON/CONCRETE FINISHER	$22.04	$9.70
CARPENTER, INCLUDES ACOUSTICAL CEILING INSTALLATION AND FORM WORK (EXCLUDES DRYWALL HANGING AND DRYWALL FINISHING/TAPING	$24.47	$8.55

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available htttps://www.dol.gov/agencies/whd/government-contracts.

Note: Executive Order 13658 generally applies to contracts subject to the Davis-Bacon Act that were awarded on or between January 1, 2015, and January 29, 2022, and that have not been renewed or extended on or after January 30, 2022. Executive Order 13658 does not apply to contracts subject only to the Davis-Bacon Related Acts regardless of when they were awarded. If a contract is subject to Executive Order 13658, the contractor must pay all covered workers at least $13.65 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract from May 11, 2026, through December 31, 2026. The applicable Executive Order minimum wage rate will be adjusted annually. Additional information on contractor requirements and worker protections under Executive Order 13658 is available at www.dol.gov/whd/govcontracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classifications and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than SU , UAVG , SA , or SC denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The SU identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

SU wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1). State Adopted Rate Identifiers The SA identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination.

The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the SA identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:
   a) a survey underlying a wage determination
   b) an existing published wage determination
   c) an initial WHD letter setting forth a position on a wage determination matter
   d) an initial conformance (additional classification and rate) determination

   On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

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U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

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2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via email to dba.reconsideration@dol.gov or by mail to:

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END OF GENERAL DECISION"

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SECTION 00830-AIP : ATTACHMENT 1

AIRPORT TERMINAL & WALKWAY HVAC EQUIPMENT REPLACEMENT
PROJECT: 2600049
AIP 3-33-0011-TBD-2026

DAVIS BACON WAGE RATES

STATE: NEW HAMPSHIRE

ROCKINGHAM COUNTY

GENERAL DECISION NUMBER: NH20260022 05/18/2026

CONSTRUCTION TYPES: BUILDING

"General Decision Number: NH20260022 05/18/2026

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The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the SA identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

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U.S. Department of Labor
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END OF GENERAL DECISION"

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SPECIAL PROVISION SECTION 01100-AIP

SPECIAL PROJECT PROCEDURES

Amend the following to Sections of 01100-AIP of the Supplemental Conditions for AIP Projects:

1.01 RADIO CONTROL

Remove this section in its entirety.

1.13 OBSTRUCTION LIGHTING AND MARKING

Add the following to the section:

All cranes shall be marked at their highest point with a red flashing beacon during the night use and 3'x3' white-red checkered flag during day use.

END OF SECTION 01100-AIP

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City of Manchester, NH, Department of Aviation

Manchester - Boston Regional Airport

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

CITY PROCUREMENT REQUISITION No. 2600049
FAA AIP No. 3-33-0011-TBD-2026

TECHNICAL SPECIFICATIONS

OCTOBER 2026

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TECHNICAL SPECIFICATIONS

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AIRPORT TERMINAL & WALKKWAY – HVAC EQUIPMENT REPLACEMENT

SCOPE OF WORK & EXISTING CONDITIONS

PART 1. GENERAL

1.1 SCOPE

A. GENERAL:

This Project consists of the phased replacement of the existing heating ventilating and air conditioning (HVAC) equipment as designated herein which serves large areas of the airport terminal and the airport terminal elevated access walkway (aka Pedestrian Bridge, or terminal walkway) at Manchester-Boston Regional Airport (Airport / MHT / Owner).

The Owner is procuring this work through a Design-Build (DB) alternative delivery method. This Request for sealed Competitive Proposals (RFP) contains preliminary design (bridging) documents including detailed project scope, design and construction requirements information, existing conditions information, basic trade work specifications, and equipment performance specifications. The DB Contracting Entity, whether it be a construction management / general contracting / construction firm, an engineering design firm, or other organization, is and may also be referred to as "Contractor", "Bidder", “Designer”, and/or “Design-Builder” herein and elsewhere in the Project Documents (including the RFP) and in all cases shall be construed as the same entity.

The technical information provided in the RFP is intended for use by the DB Contracting Entity to assist in the preparation of the DB Competitive Proposal submittal (Proposal / Bid) and in the final design development and construction of the Project. The Contractor shall field verify all information and dimensions obtained from reference documents provided with the RFP, or anywhere throughout the RFP documentation, as necessary to confirm the proposed project pricing before submitting a Proposal and for use in the final design. The existing conditions information and proposed equipment performance specifications are not comprehensive of all information required to construct the project. The Design-Builder shall obtain and verify all additional information as necessary to include all required work and costs in the Proposal price and to develop the final design documents.

The Design-Build general scope includes the final design, procurement, and construction for the phased replacement of one (1) large custom packaged hydronic heat (glycol) / direct expansion cooling (DX) Air Handling Unit (AHU) that provides HVAC to the terminal

building and five (5) gas-fired heat / direct expansion cooling (DX) packaged Rooftop Units (RTUs) that provide HVAC to the airport terminal access walkway. The AHU is located on the terminal roof and services portions of the terminal lobby and concourse, and other smaller spaces. The RTUs are located on the pedestrian bridge roof and service the entirety of the terminal walkway spaces. The age of the existing equipment ranges between 26 and 28 years old. This Project will replace the equipment with new more energy efficient equipment.

The project will be partially funded by the Federal Aviation Administration (FAA) through an Airport Improvement Program (AIP) Grant(s), therefore specific Supplemental Conditions for AIP Projects and related Federal Contract Provisions will apply, including but not limited to Buy America requirements for steel and manufactured products and Davis-Bacon Wage Rate requirements (refer to the related sections of the Contract Documents for additional requirements, information, and FAA required federal contract provisions).

The Design-Builder shall be responsible for all work necessary to complete the final design, equipment procurement, and construction of all structural, architectural, electrical, mechanical/plumbing/HVAC, systems and components, and temporary works, associated with the removal and installation of the HVAC equipment identified for replacement.

The Design-Builder shall minimize the duration of HVAC equipment outages and related systems outages to the extent possible. The Airport anticipates that the HVAC equipment will be inoperable for several days in order to remove and replace the equipment. The Design-Builder shall plan, schedule, and coordinate the work with the Airport to minimize the outage durations and reduce any need for temporary HVAC measures to the extent possible.

The performance of construction is expected to require extended working hours, multiple shifts, and night work for some portions of the work related to impacts on airport operations and building occupancy, and to minimize durations of affected systems outages. The CONTRACTOR SHALL INCLUDE ALL SHIFT DIFFERENTIAL AND OVERTIME PAY IN THE PROPOSAL PRICE. Work that may or will (subject to Owner coordination and approval) require extended shift efforts or performance outside of normal daytime working hours / night work includes:

- Demolition and preparations (including systems shutdowns) for removal of HVAC units
- Rigging and lifting of existing and new AHUs over the terminal building shall be planned to be performed during daylight hours, potentially on extended working days or during weekends, and shall be scheduled and coordinated in advance to minimize impacts on Airport operations in the terminal building and on the aircraft ramp.
- Rigging and lifting of existing and new RTUs over the Pedestrian Bridge shall be performed during periods of low vehicular roadway and pedestrian traffic

activity to be determined by the Airport, which may be at night or specific limited hours of the daytime. Replacement of RTU-5 is expected to occur at night during short-term Airport Road (terminal curb) closure/detour between 1:30 am and 4:00 am, unless the Contractor can plan to replace RTU-5 without road closure.

- Roofing and sealing work and/or weather protection
- Reconnection of new equipment to related systems (including systems shutdowns)
- Testing and air balancing (in some areas subject to coordination)
- Installation, startup / shutdown, or removal of any planned temporary HVAC (heating/cooling) measures (to be included in the Proposal Allowance)

B. PROJECT PHASING

The Project shall be designed and planned as a comprehensive package including the replacement of the five RTUs, the AHU, however it will be executed in a phased manner which will require multiple site mobilizations for the work. The anticipated project phasing is as follows:

Phase-1 Final Design and Equipment Procurement Submittals

Phase-2 Installation of terminal access walkway (Pedestrian Bridge) Rooftop Units (RTUs) No. -1, -2, -3, -4, and -5 (this phase may be sub-phased if more than one mobilization is planned by the Design-Builder's Technical Construction Approach)

Phase-3 Installation of Terminal building Air Handling Unit (AHU) No. 5

C. PROJECT SCHEDULING

It is the Airport's intent to advance final design, procurement, and construction of the Project as soon as feasible, subject to phased funding availability, seasonal weather considerations, and varying equipment fabrication and delivery durations. The Airport anticipates Contract execution to occur approximately within the January 2027 to February 2027 timeframe, following FAA/NHDOT release of FFY-26 grant funding.

The Design-Builder shall submit a detailed preliminary project schedule Gantt Chart (MS-Project or Primavera, or approved alternate) with the Proposal. The submitted schedule shall indicate task-level durations and estimated equipment delivery timelines with start/end dates, critical path identification, and milestones. Refer to other sections of the RFP and Project Documents regarding Project scheduling for additional related information and requirements.

The shutdown and replacement of the terminal building Air Handling Unit is expected to be performed during periods when seasonal weather is moderately cool (spring or fall), and the need for temporary cooling will be minimized. The Design-Builder's Technical Construction Approach narrative and proposed schedule submitted in the Proposal shall include discussion and considerations to mitigate temporary HVAC (heating & cooling) measures.

The preliminary project schedule submitted with the Proposal will be used as part of the evaluation and selection process as described elsewhere in the RFP. The project schedule shall, in addition to other appropriate tasks, include at least the following projected milestones:

- Contract Execution (*presume February 15, 2027 for Proposal schedule purposes*)

- Design / Phase-1 (AHU-5 & RTUs)
  - Field Verifications
  - Building Heat Load Calculations & Report (include Review/Approval)
  - Final Design Development
  - Equipment Manufacturer Submittals (for each Unit - include Review/Approval)
  - Construction Details Drawings Submittals (include Review/Approval)

- Construction (start/end) Dates by EACH Phase or Sub-Phase
  - Equipment Delivery - Release of Order and FOB Site
  - Site Mobilization
  - Building Hydronic Heating System Modifications for AHU-5
  - Temporary Heating / Cooling Measures (if required depending on seasonal timing)
  - Equipment Disconnection / Removal / Demolition
  - Preparations for New Equipment
  - New Equipment Placement (including projected crane lift date)
  - New Equipment Interconnections / Roofing & Sealants
  - Commissioning
  - Air Balancing
  - Completion / Acceptance & Commence Warranty Period

D. SAFETY & WORK AREA PLANNING

The Design-Builder shall prepare and submit a project-specific written Safety Plan Compliance Document (SPCD) to the Airport for review at least 30 days prior to site mobilization(s) for each phase of the Project. The plan shall also include provisions addressing the requirements and procedures of the FAA Advisory Circular 150/5370-2G

(current edition) "Operational Safety On Airports During Construction" as applicable to this work including vehicle / equipment access, work area capture and protection, and any use of cranes or other tall lifting equipment on the Airport. The Design-Builder will be required (during the design phase) to determine the size, height, and location of the cranes needed to replace the HVAC equipment in order for the FAA to evaluate potential 14 CFR Part-77 aeronautical surface impacts and facilitate timely submittal of FAA Form 7460-1 *Notice of Proposed Construction or Alteration* to the FAA at least 45 days prior to the start of construction for evaluation and determination of No Hazard to Air Navigation.

The ground level work capture area for the AHUs replacement is anticipated to be on the terminal ramp at and adjacent to Aircraft Gate 7. The approved capture area shall be configured such that there are adequate clearances and no interference with nearby Aircraft and Ground Support Equipment (GSE) operational requirements (gate approach routes, Taxiway and Taxilane Object Free Areas, GSE maneuvering areas, etc.), the Terminal Ramp Service Roads, adjacent gate support operations, and terminal building access doors / Tug-way openings. Access to the AHUs work capture area will be through Gate #28 at the north end of the terminal and along the designated vehicle service road. Refer to the HVAC GENERAL SITE PLAN provided in Appendix-A of the Technical Specifications (Appendix-A) for the work areas general operational envelopes.

The Design-Builder shall provide and install all construction area barricades, warning devices, and signage as required by the Project Documents and as approved by the Airport. The Design-Builder shall also pre-coordinate with the Airport and submit a gate-specific work area capture plan as part of the safety plan indicating the locations the construction area barricades. Refer to the GENERAL NOTES & ACCESS DETAILS provided in Appendix-A for additional information on safety requirements and aviation barricades.

Contractor vehicles allowed to access the airfield worksite areas will be limited to the minimum necessary to transport tools, material, and equipment. Contractor Vehicles shall be marked with company name/logo identification and a flashing yellow beacon and shall be escorted by an Airport vehicle during all movements into and out of the airfield work area. Advance coordination and notice of at least 24 hours is required for vehicle access into the airfield work areas. Delays resulting from insufficient coordination for access shall not be basis of Contractor claims.

The ground capture area and access routes for each work area location for the RTUs will vary and shall be configured such that landside roadway circulation traffic and pedestrian access to and around the terminal building, the rental car customer service facility, and the parking garage, including fire lanes, is maintained or temporarily re-rerouted in a manner as approved by the Owner. Refer to the HVAC GENERAL SITE PLAN provided in Appendix-A for the work areas general operational envelopes.

Performance of work outside of normal working hours may be required for utility shutdowns or for heavy crane lifts of equipment over publicly accessible building areas

for safety considerations and to minimize impacts on airport terminal and ramp operations. The Design-Builder shall become familiar with these restricted site access conditions and non-standard work hours requirements in the preparation of the Proposal and include all necessary considerations in the Proposal price.

All Design-Builder's personnel who will be onsite daily or regularly (as required by the Airport) during construction will be required to complete Airport Security Screening (including fingerprinting, two forms of ID, and background checks) and limited (approximately 1 to 2 hours) training to obtain Airport-issued Security Access Badges. Personnel without a security badge must be always accompanied by a properly badged escort (contractor staff or Airport) when present in the secure areas of the Airport. It is expected, at a minimum, that the Site Superintendent / Foreman and primary Installation Technicians will obtain security badges.

E. FINAL DESIGN

The Design-Builder shall provide the final design of the project based on the requirements provided in the RFP and Project Documents in accordance with the appropriate building codes and best design practices. The final design shall be performed by Professional Engineers registered in the State of New Hampshire for the respective discipline specialties and whom shall seal the construction issue documents.

The RFP provides preliminary design (bridging) documents from which the Design-Builder shall base the scope of final design and construction work. These include general site plans, HVAC equipment (performance) specifications and general trades work and materials specifications, illustrative figures and annotated plans, and other reference such as existing conditions information, to set the minimum work standards and expectations for the design and construction of the Project overall.

Additional existing conditions reference documentation (drawings) will be provided to the Design-Builder during the final design process. The final design shall develop the construction details as required for a complete installation and bear full responsibility of building code compliance. Final construction details and documents shall be subject to Owner review and approval which shall not relieve the Design-Builder of any statutory or code compliance responsibility.

1. Verification:

   The Design-Builder’s final design team shall field verify all dimensions and existing conditions and shall obtain any supplemental reference information necessary to complete the final design and construction details. Available Airport reference documents, including selected original building details and drawings from interim modification projects, will be provided to the selected Design-Builder for reference. These documents may not include all information required for the Work and may not

accurately represent existing conditions; therefore, the Design-Builder's design team shall independently verify the information in the field.

Existing reference documents anticipated to be provided to the selected Design-Builder for final design informational use (with verifications as necessary) include, but are not limited to:

- Terminal Building Floor Plans
- Interior ductwork system & Variable Air Volume Terminal Box (VAV) plans
- Terminal Building hydronic heating plans
- BAS/BMS existing data point lists & location diagram of BAS/BMS hardware
- 2012 VAV Box upgrades plans
- 2012 Solar window film project – Terminal Building
- 2010 Glass replacement project – Pedestrian Bridge
- 2015 Replacement of AHU-1, -2, -3, -4 with chilled water system plans
- Terminal Building balancing reports (partial) 2002 / 2014
- 2023 Fire Alarm System Upgrade
- 1998 & 2002 Smoke Evacuation System schematic drawings

2. Design Development:

The final design scope shall include development of complete detailed work specifications, construction planning, construction-issue drawings and details, final equipment selection and procurement documentation prior to equipment manufacturer order release and required design-phase and construction-phase submittals to the Airport for review and approval. At a minimum, submittals shall include a 70% design submittal and a 100% construction submittal. Interim or partial submittals may also be requested or submitted, as appropriate, to support the project schedule and ongoing design development.

The Design-Builder shall begin final design activities as soon as practicable following Contract execution. The Design-Builder's project schedule, submitted with the Proposal, shall include anticipated design progress milestones and preliminary forecasted submittal dates.

3. Building Heat Load Calculation & HVAC Equipment Capacity Confirmation

The initial segment of the final design shall include a Terminal Building and Pedestrian Bridge HVAC (cooling & heating) Load Study and Report (HL Study). The HL Study shall include investigation of the existing facility and systems, and heat load calculations using appropriate and Airport-approved industry-proven software (such as Trane TRACE 3D-Plus, Carrier Hourly Analysis Program (HAP), Integrated Environmental Solutions VE, EnergyPlus/OpenStudio, or Approved Alternate).

The HL study shall include all areas of the buildings as necessary to confirm that the capacities of the proposed HVAC equipment to be installed under the Project (AHU-5 and the RTUs) with the additional inclusion of Air Handling Units AHU-6 and AHU-7 (intended for replacement soon), are adequate to service the building for the appropriate design parameters. The results shall also assist in determining the design air delivery volumes at each discharge of the points which will also be utilized for the air & hydronic balancing work after installation of the new equipment.

Summer and Winter Design Parameters, including occupancy levels, to be used in the HL Study shall be recommended to, coordinated, and approved by the Airport prior to performing the study. Ventilation rate(s) shall be per ASHRAE 62.1 occupancy calculations and applicable energy code. The Airport anticipates utilizing HVAC design condition (criteria) consistent with or more conservative than current NH Energy Code, and/or Design-Day conditions as follows:

- Summer Outdoor design (0.4%): 91°F DB / 71.6°F WB
- Summer Indoor target: 72°F DB / 50% RH
- Winter Outdoor design: 0°F DB
- Winter Indoor target: 70°F DB / < 30% RH
- Condensing unit equipment shall be sized to 5 degrees over summer outdoor design temperature

Based on current and historical observations within the Terminal Building and Pedestrian Bridge, the existing HVAC equipment appears capable of adequately heating and cooling the occupied spaces when operating at full available design capacity. However, the age and condition of the equipment may reduce system output, and periodic service interruptions or maintenance outages can result in problematic building conditions. The summary of the 2009 HVAC Load Calculation Memo indicated that the stated design capacities of the existing HVAC equipment were considered adequate. In addition, several HVAC system improvements have generally been completed since the 2009 HVAC Load Calculations were prepared. The 2009 HVAC Load Calculation memo - Terminal Building & Pedestrian Bridge in included in Appendix-A for reference purposes only.

The Airport anticipates that the HL Study will confirm the appropriate equipment capacities. The HL study shall be performed for the three (3) large custom packaged Air Handling Units servicing the 1998 and 2002 terminal building areas (AHU-5, AHU-6 and AHU-7) and the five Terminal Walkway RTUs as listed in the RFP are generally sufficient to serve the building, as supported by observed facility conditions when the existing HVAC systems are operating properly, with only limited potential variance expected.

The Proposal price shall include new HVAC equipment with minimum capacities at least equal to the existing equipment capacities stated in the RFP. If the HL Study determines that equipment capacities greater than the existing capacities are required

or appropriately recommended, such larger-capacity equipment may be provided only at the Owner's discretion, subject to HL Study review and the Owner's written approval. If approved by the Owner, any necessary associated adjustment to the Contract price would be made by a negotiated amount agreed upon by the Owner and Design-Builder.

F. DEMOLITION AND TEMPORARY HVAC MEASURES

The Design-Builder's scope includes the removal and legal disposal of existing equipment, affected components, and related system appurtenances. The Design-Builder shall provide all new materials, components, appurtenances, and temporary or ancillary work necessary to complete the HVAC equipment replacement.

The Contractor shall safely remove / evacuate all refrigerants from the existing equipment prior to the commencement of any demolition work for that unit. All or some of the evacuated and recovered refrigerant (R22) from the existing HVAC equipment (as an aggregate) shall be delivered to the Owner. The refrigerant shall be delivered in appropriate gas cylinders / tanks, in a filtered and ready-to-use state, to the extent and quantity as directed by the Owner's representative, up to 200 pounds of refrigerant. Any remaining refrigerant shall be legally disposed of by the Contractor.

The HVAC system, along with all interconnected systems, must remain fully functional during (except for scheduled and approved intermittent shutdowns) and between phased construction periods. Temporary building heating or cooling measures (also referred to as "temporary HVAC") may be required to maintain acceptable conditions in customer and tenant areas during extended shutdowns for equipment replacement, and will be dependent on construction sequencing, seasonal conditions, equipment delivery timing, and the duration of service interruptions.

The Design-Builder shall coordinate with Owner's Representatives when scheduling systems shutdowns and the equipment installations to determine if, and to what extent, temporary HVAC measures may be needed. In some scenarios, temporary HVAC may not be needed at all. In others, it may require some relatively limited measures or potentially more involved solutions.

The Design-Builder shall strategically plan and coordinate the Project work to minimize the need for temporary HVAC measures. This could include potential systems final design considerations or other project characteristics to mitigate temporary HVAC needs. The Design-Builder shall provide a discussion and description of anticipated needs for, and potential conditions and methods related to, temporary HVAC measures in the Technical Construction Approach (TCA) narrative to be provided in the Proposal which will be used as part of the evaluation and selection process as described elsewhere in the RFP.

Because the extent and duration of temporary HVAC measures may not be fully defined prior to contract award, the Proposal price (Bid) and resulting Contract will include a dedicated Allowance (as established and may be modified by the Owner) for Temporary Heating/Cooling Measures. The methodology, scope, and actual costs to be paid for any temporary HVAC measures to be assigned to the contract allowances shall be proposed by the Contractor as the final design and construction planning/scheduling progresses.

The temporary HVAC measures shall be negotiated with, and approved by, the Owner in writing prior to deployment of such measures. This approach is intended to help avoid widely varying contingency pricing in the Proposals and allows temporary solutions to be selected based on actual prevailing field conditions at the time of construction.

G. AFFECTED AND RELATED SYSTEMS

Affected and related systems that are interconnected to the HVAC equipment to be replaced include but are not limited to:

1. Fire Alarm & Detection System

   The Contractor shall remove and replace existing components of the Fire Alarm and/or Detection System as necessary for the construction of the project including but not limited to smoke detection in the ductwork and/or interior to the HVAC equipment. The Terminal Building and Pedestrian Bridge existing fire alarm system has been recently renovated and is an Edwards EST-4 Emergency Communications and Life Safety Platform. All new devices or components which may be provided with the work and proposed HVAC equipment interconnections must be compatible with the existing Fire Alarm System. Programming adjustments to the Fire Alarm System may be required to accommodate the new equipment. Programming work shall be performed by the Airport's Fire Alarm System maintenance contractor, and the associated cost shall be included in the Proposal price.

   After modifications and/or reconnections are made for this project, and as part of commissioning and acceptance, the Fire Alarm and Detection systems and the Terminal Building Smoke Evacuation System must undergo a live test(s) with the Owner's Representatives and the local AHJ (Londonderry Fire Department) present.

2. Building Electrical Systems

   The Contractor shall deenergize the electrical power to the HVAC units at the main breaker within the associated electrical rooms and apply Lockout/Tagout (LOTO) protection in accordance with safety regulations and Owner instructions. Existing electrical circuit information, including existing cable sizes and the locations of the

equipment main breakers are indicated in the existing conditions descriptions later in this section and on the Single Line Diagrams provided in Appendix-A.

Existing conduits and cables attached to the HVAC units shall be cut back and removed to the extent needed to facilitate equipment extraction. Conduits and cable ends shall be insulated, made safe, and secured within temporary enclosures. These circuits shall subsequently be extended to the new equipment to ensure a complete and operational installation.

The Design-Builder shall verify that the existing electrical power feed is of sufficient size and capacity to power the proposed equipment as part of the bidding process. If the Design-Builder's proposed equipment design requires a new electrical feed (cables) for any of the new HVAC units, then complete removal of the existing power cables shall be performed, and all costs for installing the new power feeder(s), including conduit if required, shall be included in the Proposal. The Design-builder shall state the proposed intent for electrical feeders for each piece of HVAC equipment in the Technical Construction Approach (TCA) narrative to be provided in the Proposal.

3. Terminal Building Hydronic Heating System

The Building Hydronic Heating System supplies AHU-5, AHU-6, and AHU-7 (AHUs) with ethylene glycol through a distribution system that is interconnected with other heating elements throughout the terminal building. The AHUs cannot be individually isolated from the glycol distribution system outside of the valve manifolds that are located inside the existing AHU enclosures.

The isolation valves and low-point drains for the supply and return main glycol piping lines to and from the AHUs (and other equipment) are located on the lower ground level of the building. The glycol piping system consists of schedule 40 steel pipe with welded fittings and accessories. In order to remove, modify, and/or relocate the existing glycol piping connections that are located inside the AHU enclosures a significant volume of glycol would need to be drained down and refilled.

Since the shutdown and replacement of the AHUs is expected to be performed during a period when seasonal weather is moderately cool (spring or fall), and therefore the need for temporary cooling would be minimized, the building hydronic heating system will need to remain active during that period.

Prior to mobilization(s) for HVAC equipment demolition, and during a seasonal non-heating period, the Contractor shall drain down the affected portions of the glycol distribution system for AHU-5 and install localized AHU isolation valves in the dedicated glycol supply and return branch lines to AHU-5.

The Contractor shall test the drained hydronic heating system fluid for appropriate chemical concentration to be specified by the Owner. Additional Ethylene Glycol chemical that may be needed for concentration adjustment or make-up volume when refilling the hydronic heating system piping will be provided by the Owner for the Contractor's use in refilling the system.

The approximate locations of the proposed AHU isolation valves are anticipated to be in the vertical piping risers to each AHU extending from above the ground floor ceilings generally below the existing AHUs. The proposed valve locations shall be determined by the Design-Builder's construction approach and final design. The existing vertical glycol pipe risers up to the AHUs are generally located above the following ground floor at the TC4-TC5 CBRA Room #11xx for AHU-5, This room and the work areas for glycol drain down, will be visited as part of the Pre-Proposal Meeting for the Design-Builder's observance of the existing conditions and inclusion of all necessary work and protection of room finishes.

The existing glycol system zone isolation valves and low-point drains are located in the Tug-way Garage(s) on the ground level where the Owner will provide and place temporary glycol storage tanks for use by the Contractor in draining down and storing the glycol during construction activities. The Contractor shall provide all necessary temporary work and equipment to drain the glycol lines into the tanks and to refill and test the glycol distribution system. Refer to Appendix-A of the Technical Specification for ILLUSTRATIVE FIGURE-1: AHU-5 GLYCOL-&-DUCT for the existing connected glycol piping below AHU-5.

The glycol system work for AHU-6 and AHU-7 is not included in the contract (N.I.C.) and ILLUSTRATIVE FIGURE-2: AHU-6&7 GLYCOL for the existing connected glycol piping below AHU-6 and AHU-7, is included for general system informational reference only.

The Design-Builder's Technical Construction Approach (TCA) narrative to be provided in the Proposal, shall include a discussion of temporary and permanent work planned for modifications to the AHU-5 glycol distribution system. Since the shutdown and replacement of the AHU is expected to be performed during periods when seasonal weather is moderately cool (spring or fall), and therefore the potential need for temporary cooling would be minimized, the building hydronic heating system will need to be active during that period.

If the Design-Builder's construction approach and proposed equipment configuration can facilitate the removal of the existing equipment and installation of the new AHU without affecting the glycol distribution system and/or requiring a drain down and new branch isolation valves installation, then specific detail must be provided addressing that option, and noting a related potential price/cost reduction, in the Technical Construction Approach narrative provided in the Proposal.

Testing, adjusting, and balancing shall be performed for the portions of the terminal building hydronic heating system that were affected by the HVAC equipment replacement. Related costs for each system shall be included in the respective Bid Item pricing. Refer to Section 3.5 ACCEPTANCE REVIEW AND TESTS / COMMISSIONING for additional information.

4. Structural Support and Roofing Systems

It is anticipated that the new HVAC equipment will be of similar capacity, physical size and weight as the existing equipment. The terminal building AHUs are custom-built packaged units for which the bearing footprint could be adjusted to suit re-use of the existing AHU support curbs with or without curb adaptation framing. The existing AHU roof curb dimensions, configuration details, and existing equipment weights are provided in the AHU-5 Equipment Manufacturer Reference Data included in Appendix-A.

The existing roof curbs on the terminal building for the three AHUs may be re-used by the Design-Builder to support the new equipment or be demolished and replaced at their proposed option, however, the Technical Construction Approach (TAC) provided in the proposal submittal must state whether the Design-Bulder will re-use the existing roof curbs, with adaptation if needed, or replace them and shall include all related costs in the Proposal price.

If the existing AHU-5 curb is to remain, the Design-Builder shall confirm the capacity of the existing curb elements to ensure adequate support in accordance with applicable building codes. The structural design for new, or capacity verifications of existing elements, for the proposed equipment support (utilizing existing curbs or not) shall be performed in accordance with all applicable codes, standards, and guidelines and shall be certified/sealed by a Professional Engineer licensed in the State of NH and submitted as a design report to the Airport for record. Excerpts from the existing building roof framing drawings are provided as Illustrative Figures in Appendix A for the Design-Builder's reference in preparation of the Proposal.

The Design-builder shall also inspect the remaining existing roof curb components and supporting structural elements (prior to and/or during construction) for any defects or corrosion that might affect the strength or longevity of the system, provide documentation of the observed conditions (photos, sketches, and narratives), and if necessary, propose repairs or preservation measures to the Owner.

The existing roof curbs for the five Pedestrian Bridge RTUs may re-used by the Design-Builder to support the new equipment or be demolished and replaced at their

proposed option, however, the TAC in the Proposal submittal must state whether the Design-Bulder will re-use the existing roof curbs, with adaptation if needed, or replace them and shall include all related costs in the Proposal price.

The existing roof curb flashings, sealants, roofing membrane and insulation around the perimeter of all the HVAC equipment to be replaced (AHU-5 and RTUs) shall be cut back, demolished and replaced at least to the limits indicated on the localized ENLARGED HVAC PLANS provided in Appendix-A or as described elsewhere in the Project Documents. Roofing work shall conform to the requirements of the related roofing technical performance specifications included in the RFP and supplemental specifications and details to be developed in the final design by the Design-Bulder and approved by the Owner, in accordance with building code, the roofing and flashing specifications, any requirements necessary to obtain the specified warranty and referenced industry standards. Existing roofing information is provided in Appendix A for the roofing materials in the work areas and the adjacent (abutting) areas.

The Contractor may, at their discretion to suit their work plan, elect to remove and replace additional roofing (membrane and insulation together) extending beyond the limits indicated in the RFP, however all related costs for the additional roofing replacement shall be done at no additional cost to the Owner and shall be included in the base Proposal price. If roofing removal beyond the indicated limits is planned, then the Design-builder shall state and/or illustrate the intended roofing limits in their Technical Construction Approach (TCA) narrative to be provided in the Proposal.

Design-Builder shall provide a unit price ($/SF) to the Owner (to be stated in the TCA) for any additional removal and replacement required and as directed by the Owner's representative in writing, because the existing roof is wet, deteriorated, or otherwise unsuitable AND the condition was not reasonably observable before demolition.

The Contractor shall remove the existing roofing protection access walkway matting serving and surrounding the HVAC equipment within the limits of the roofing replacement work, including any additional areas indicated. New walkway matting materials shall be provided in a similar configuration to the patterns shown on the ENLARGED HVAC PLANS in Appendix A, or in an alternate configuration coordinated with the clearances and maintenance access requirements of the new equipment, subject to Owner approval.

Condensate drains for each piece of equipment AHU-5 and the RTUs shall be hard-piped to discharge into a nearby existing roof drain fixture where feasible, without allowing open flow across the roofing membrane. Condensate drain piping that cannot be routed to a roof drain shall be hard-piped away from the equipment and discharged onto protective splash blocks provided to protect the roofing membrane.

The Contractor shall provide temporary weather protection for open roofing and flashing areas to protect the building envelope from water infiltration during construction. Damage or staining to the existing facilities caused by water infiltration at the work areas during or directly following construction within the warranty period shall be repaired by the Contractor at no additional cost to the Owner. The contractor shall also protect all existing roof membrane to remain to prevent any damage during construction and so as not to void any existing warranty.

The Contractor shall inspect and document the existing condition of the roofing in all areas encompassed by, and adjacent to, the construction operations and access routes. All existing defects, leaks, or unsuitable conditions shall be identified to the Owner in writing with a specific description and location sketches prior to commencement of construction. The contractor shall correct any leaks or defects that occur as a result of the construction activities.

Structural and ancillary supports, roof curb adaptation framing, attachment brackets/hardware, flashings, etc., shall be fabricated from corrosion resistant materials consisting of aluminum, stainless steel, or hot-dipped galvanized steel. All exposed or weather / atmospheric conditions affected bolts, screws, fasteners etc. shall be hot-dipped galvanized or stainless steel unless otherwise approved by the Airport for specific applications / locations as submitted during the final design phase. Protective separation for reactive dissimilar materials in contact shall be provided when applicable.

5. Air Distribution & Smoke Evacuation / Detection Systems

   a. Air Handling Unit No. 5 (AHU-5):

      The supply and return ductwork connected to AHU-5 is routed from inside the building up through the 1998 building expansion roof within the limits of the AHU roof curb. Mechanical / ductwork record drawings for the AHUs will be provided to the selected Design-Builder for final design reference.

      The Design-builder shall inspect the existing ductwork and related components adjacent to the AHU that are to remain (to the extent feasible during the design phase using remote cameras and then during construction when the AHU is removed) for any defects or corrosion that might affect the strength or longevity of the system, provide documentation of the observed conditions (photos, sketches, and narratives), and if necessary, propose repairs or preservation measures to the Owner.

      New localized ductwork transitions / connections to the proposed AHU-5 air supply and return openings shall be provided to suit the new equipment installation. The existing AHU-5 smoke evacuation system dampers are anticipated to remain

in place, however, they shall be cleaned, lubricated, and tested as part of the AHU-5 start-up and commissioning. Refer to Appendix-A for: the AHU-5 Equipment Manufacturer Refence Data for the locations and size of the existing equipment supply and return openings, and to ILLUSTRATIVE FIGURE-1: AHU-5 GLYCOL-&-DUCT for the existing connected ductwork configuration below the AHU.

After modifications and/or reconnections are made for this project, and as part of commissioning and acceptance, the Fire Alarm and Detection systems and the Terminal Building Smoke Evacuation System must undergo a live test(s) with the Owner's Representatives and the local AHJ (Londonderry Fire Department) present.

b. Rooftop Units No. 1 through No. 5 (RTU-1, RTU-2, RTU-3, RTU-4, RTU-5):

The supply and return ductwork for the Pedestrian Bridge rooftop units is routed from inside the building up through the roof within the limits of the existing roof curbs. Fire alarm detection exists in the supply and return ductwork for each RTU. If the removal and installation of the new equipment and duct transitions affect the duct detection devices, then reinstallation and testing shall be included in the Proposal price. Pedestrian Bridge mechanical / ductwork record drawings will be provided to the selected Design-Builder for final design reference.

The Design-Builder shall inspect the existing ductwork and related components locally adjacent to the RTUs that are to remain (to the extent feasible during the design phase and then during construction when the units are removed) for any defects or corrosion that might affect the strength or longevity of the system, provide documentation of the observed conditions (photos, sketches, and narratives), and if necessary, propose repairs or preservation measures to the Owner.

New ductwork transitions / connections to the proposed equipment air supply and return openings shall be provided to suit the new RTUs equipment installation. Existing ductwork sizes for supply and return air routed to/from each of the RTUs are as follows:

ROOFTOP UNIT#.	Supply Air Duct	Return Air Duct
RTU-1	42x14	28x16
RTU-2	54x24	(two) 26x24
RTU-3	54x24	(two) 48x38
RTU-4	54x22	(two) 48x32

RTU-5	24x14 and 32x14	(two) 20x22

c. Testing, adjusting, and balancing (TAB) shall be performed for the portions of the terminal building and Pedestrian Bridge air distribution systems that will be affected by the HVAC equipment replacement. Related TAB costs for each system shall be included in the respective Bid Item pricing. Refer to Section 3.5 ACCEPTANCE REVIEW AND TESTS / COMMISSIONING for additional TAB information.

6. Natural Gas Distribution System (Terminal Walkway / Pedestrian Bridge only):

Existing natural gas piping serving the Pedestrian Bridge RTUs is routed from an interior ceiling-space piping loop of varying size, up through the roof adjacent to each RTU, with local shut-off valves provided at the units. The 2-1/2-inch gas service main connects to a grade-mounted meter located at the Pedestrian Bridge center service building. The existing exterior gas piping and valves exhibit surface corrosion and shall be replaced from the new equipment connections down through the roof to a connection point within the interior ceiling space. New gas piping shall be painted orange utilizing weather resistant coatings. Provide new roof flashings, boots, and sealants at all affected penetrations. Existing natural gas piping sizes at each of the RTUs are as follows:

ROOFTOP UNIT#.	Nat Gas Pipe Size
RTU-1	1”
RTU-2	1-1/4”
RTU-3	1-1/4”
RTU-4	1-1/4”
RTU-5	1-1/4”

7. Building Automation/Management (BAS/BMS) System:

a. General

The Airport’s BAS/BMS-controlled conditioned space facilities, consisting of the Terminal Building, the Terminal Access Walkway (Pedestrian Bridge), and the Airfield Rescue Fire Fighting & Maintenance Building (ARFF building), are currently served by an existing Johnson Controls Metasys (Release 7.0) Building Automation System. The existing system consists of a combination of a legacy N2 Open network trunk and distributed N2 devices of varying age (starting circa 1993)

with some updated (compatible) BACnet MS/TP communication network devices that have been installed as part the 2015 chilled water system and AHU-1-2-3-4 replacement project. There are 10 existing Network Automation Engine (NAE) controllers of varying age and type/models at locations distributed throughout the related facilities.

The existing BAS architecture, monitoring, scheduling, trending, alarming, and operator interface functions shall remain fully operational throughout construction unless otherwise approved by the Owner. New HVAC equipment and associated controls shall be fully compatible and interoperable with the existing BAS/BMS.
The Design-Build contractor shall provide all BAS/BMS modifications, controllers, programming, graphics, integration services, communications infrastructure, and related work necessary to fully integrate all HVAC equipment and associated systems replaced or modified under this Contract into the existing Johnson Controls Metasys BAS/BMS.

This shall include all associated terminal units, field devices, sensors, actuators, control valves, alarms, trends, schedules, graphics, databases, and operator interface modifications as necessary to provide a complete and fully functional system.

All new controllers provided under this Contract shall be current-generation products compatible with the existing BAS architecture and communications networks, including existing N2 Open and BACnet MS/TP networks, and shall be suitable for continued use under a future BAS/BMS modernization to be implemented under a separate contract.

The Design-Builder shall provide all controller programming, network integration, point mapping, alarm and trend configuration, scheduling functions, graphics modifications, database revisions, communication modules, routers, gateways, software licenses, and all other hardware, software, and services necessary to achieve complete integration and operation of the new HVAC equipment within the existing Johnson Controls Metasys BAS/BMS.

The Design-Builder shall ensure that all new equipment maintains the same level of monitoring, alarming, scheduling, trending, reporting, and operator control currently provided through the existing Metasys system. The controls architecture developed under this Contract shall be designed such that newly installed controllers, field devices, sensors, actuators, and associated control components may remain in service and be reused under any future BAS/BMS modernization to be implemented under a separate contract.

b. Occupied Terminal Requirements

The terminal building shall remain occupied and operational throughout construction. The Design-Builder shall coordinate all BAS/BMS shutdowns, cutovers, controller replacements, network modifications, and system integrations to minimize impacts to Airport operations. Work requiring interruption of BAS/BMS functions, controller replacement, VAV control modifications, network cutovers, system integrations, testing, or commissioning activities shall be performed during approved off-hours, night shifts, weekends, or other Owner-approved periods.

The Design-Builder shall include all labor, materials, temporary controls, temporary monitoring, temporary programming, temporary sequences of operation, and phased cutover measures necessary to maintain continuous terminal operations and occupant comfort throughout construction.

c. Testing, Adjusting, Balancing, (TAB) and Commissioning

Following completion of the equipment installation, the Design-Builder shall provide complete TAB for the systems, re-commissioning and functional performance testing for all affected equipment and related or interconnected components. This work shall include BAS/BMS point-to-point checkout, controller validation, graphics verification, alarm verification, trend verification, sequence of operation testing, functional performance testing, operator training, and preparation of updated as-built documentation.

H. EXISTING CONDITIONS

1. The Design-Builder shall visit the site and fully observe the existing conditions prior to submission of the Proposal to identify and include all work required for the removal of the existing equipment and appurtenances, and all modifications to the existing facilities, adjacent systems, and building structure and systems to facilitate the proposed HVAC equipment and BAS/BMS installation.

2. A site tour will be performed as part of the MANDATORY Pre-Proposal meeting to provide opportunity for the observation of existing conditions prior to preparing the Proposal to ensure all related costs are included in the Proposal price. If needed, an additional subsequent site visit may be requested by the Design-Builder (in writing via email with advance notice and subject to Owner scheduling coordination – refer to Project Documents Volume-I Section 00130).

3. Prior to commencement of design and/or construction, the selected Design-Builder shall fully inspect and document the existing conditions and functionality of all related and interconnected systems as needed for the final design and that may be affected by the proposed installation or adjacent construction operations.

4. The existing terminal building, as shown on the HVAC General Site Plan in Appendix A, was constructed in phases. The original terminal section of the building was constructed in 1993-1994 and consists of the main lobby and the portion of the building that encompasses the full building area from Gate-8 to Gate-15. The first terminal building expansion was constructed in 1998 and generally consists of a short ticket hall extension in the Gate-7 area, and further extension of the concourse area from Gate-8 to Gate-5 and the narrow glass-walled connector area. The second terminal building expansion was constructed in 2003-2004 and consists of the remaining western portion of the building that encompasses the full building area from Gate-1 to Gate-4 and the portion of the building that wraps around the north side of the 1998 expansion.

5. Boiler Plant

   The existing boiler plant consists of two 10,461 MBH natural gas-fired hydronic boilers configured in a lead/standby arrangement. The heating water system utilizes a primary/secondary pumping configuration, with hydraulic decoupling provided by two shell and tube heat exchangers (HX-1 and HX-2).

   The primary loop is served by two 560 GPM heating water pumps (P-1 and P-2), while the secondary loop is served by three 465 GPM heating water pumps (P-3, P-4, and P-5). The secondary loop distributes heating water to the preheat coils for AHU-5, AHU-6, and AHU-7, as well as to the variable air volume (VAV) terminal unit and series fan powered terminal (FPT) unit reheat coils. The secondary loop contains a 50% ethylene glycol solution.

   Two tertiary booster pumps (P-1 and P-2) are provided in a Mechanical Room on the first floor that distributes heating water to the preheat coils for AHU-5,6, & 7, as well as to the variable air volume (VAV) terminal unit and series fan powered terminal (FPT) unit reheat coils.

   Two tertiary booster pumps (BP-1 & BP-2) are provided in a Janitorial Room on the second floor near concourse Gate-8 that distributes heating water to variable air volume (VAV) terminal unit and series fan powered terminal (FPT) unit reheat coils.

6. Air Handling Unit AHU-5

   This unit was installed to service the 1998 terminal building expansion. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section. Additionally refer to the AHU-5 Equipment Manufacturer Reference Data included in Appendix-A

   AHU-5 is an 184-ton custom packaged DX roof-mounted unit. It is a variable volume unit that supplies air to series fan powered variable air volume terminal units with hydronic heating coils. AHU-5 consists of 45,000 CFM return air fan, MERV 8 filter, hydronic

heating coil, 50,000 CFM supply fan, and direct expansion (DX) cooling coil. The hydronic heating coils contain 50% ethylene glycol.

AHU-5 serves the following spaces:

- Ticket lobby including ticket counters
- Baggage Equipment Area
- Office space located between the ticket counters and baggage equipment area
- Outbound baggage
- Section of passenger concourse

7. Air Handling Unit AHU-6 & AHU-7 - Not In Contract - (Description provided for general reference and HL Study information only)

   These units were installed to service the 2004 terminal building expansion. AHU-6 was originally installed as part of the 1998 terminal expansion but was then removed and relocated onto the 2004 building expansion roof. AHU-6 and AHU-7 are tied together with shared supply and return ductwork routed exterior on the terminal roof. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section. Additionally refer to the AHU-6 and AHU-7 Equipment Manufacturer Reference Data included in Appendix-A

   AHU-6 is a 134-ton custom packaged DX roof-mounted top unit. It is a variable volume unit that supplies air to series fan powered variable air volume terminal units with hydronic heating coils. AHU-6 consists of 32,400 CFM return air fan, MERV 8 filter, hydronic heating coil, 36,000 CFM supply fan, and direct expansion (DX) cooling coil.

   AHU-7 is an 184-ton custom packaged DX roof-mounted unit. It is a variable volume unit that supplies air to series fan powered variable air volume terminal units with hydronic heating coils. AHU-7 consists of 60,000 CFM return air fan, MERV 8 filter, direct expansion (DX) cooling coil, 60,000 CFM supply fan, and hydronic heating coil. The hydronic heating coils contain 50% ethylene glycol.

   AHU-6 & AHU-7 serve the following spaces:

   - Ticket lobby including Ticket Counters and extension toe Bag Claim “A” area
   - Security Checkpoint-A area (inactive)
   - Baggage Claim “A” Area and adjacent offices / restrooms
   - Connector concourse corridor
   - Offices located between ticket lobby and baggage equipment area
   - Baggage Equipment Area
   - Office space located on west side of the building on first floor below gates 1 through 4
   - Hold-Rooms and concourse for Gates 1 through 4.

8. Rooftop Unit RTU-1

RTU-1 was installed to service the Terminal Walkway (Pedestrian Bridge) constructed in 2000 that connects the airport terminal to the parking garage and the rental car customer service facility. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section.

RTU-1 is a 6-ton packaged DX rooftop unit with 125 MBH natural gas heat. It is a 2200 CFM constant volume unit that serves the Pedestrian Bridge north escalators and stairs tower.

9. Rooftop Unit RTU-2
   RTU-2 was installed to service the Terminal Walkway (Pedestrian Bridge) constructed in 2000 that connects the airport terminal to the parking garage and the rental car customer service facility. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section.

   RTU-2 is a 20-ton packaged DX rooftop unit with 320 MBH natural gas heat. It is a 7500 CFM constant volume unit that serves the Pedestrian Bridge north entrance vestibule and section Area 'A'.

10. Rooftop Unit RTU-3
    RTU-3 was installed to service the Terminal Walkway (Pedestrian Bridge) constructed in 2000 that connects the airport terminal to the parking garage and the rental car customer service facility. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section.

    RTU-3 is a 20-ton packaged DX rooftop unit with 400 MBH natural gas heat. It is a 7000 CFM constant volume unit that serves the Pedestrian Bridge center section Area 'B' (northern).

11. Rooftop Unit RTU-4
    RTU-4 was installed to service the Terminal Walkway (Pedestrian Bridge) constructed in 2000 that connects the airport terminal to the parking garage and the rental car customer service facility. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section.

    RTU-4 is a 20-ton packaged DX rooftop unit with 400 MBH natural gas heat. It is a 6300 CFM constant volume unit that serves the Pedestrian Bridge center section Area 'B' (southern) into Area 'C'.

12. Rooftop Unit RTU-5
    RTU-5 was installed to service the Terminal Walkway (Pedestrian Bridge) constructed in 2000 that connects the airport terminal to the parking garage and the rental car customer service facility. Basic equipment data and representative photograph are listed and shown on the Existing Equipment Data Table provided at the end of this section.

RTU-5 is a 12.5-ton packaged DX rooftop unit with 200 MBH natural gas heat. It is a 4500 CFM constant volume unit that serves the Area 'C' south escalators and stairs tower and escalators area into the terminal lobby.

13. Existing Building Automation System Description

The Manchester-Boston Regional Airport Main Terminal and ARFF facilities are currently served by an aging Johnson Controls Metasys Building Automation System (BAS). The system consists of a distributed architecture utilizing multiple Johnson Controls Network Automation Engines (NAEs), DX-9100 controllers, UNT unitary controllers, and VMA terminal unit controllers communicating primarily over the legacy Johnson Controls N2 field bus network.

The BAS provides monitoring and control of terminal HVAC equipment, including:

- Air Handling Units (AHUs)
- Rooftop Units (RTUs)
- Unitary DX equipment
- Fan-powered terminal units
- Variable Air Volume (VAV) terminal units
- Exhaust fans
- Hot water booster pumps
- Smoke control systems
- Smoke dampers
- Associated mechanical room equipment and support systems

a. Supervisory Controls:

The existing system is configured around multiple Metasys NAE supervisory controllers that aggregate field controller data and provide operator access to HVAC systems. The airport currently operates approximately ten NAE supervisory devices supporting both comfort control and life-safety related smoke control functions. Existing NAE55 generation hardware is at or near end-of-life and no longer supports current Johnson Controls platform standards. The supervisory system includes:

- Centralized operator workstation capability
- Facility graphics
- Scheduling functions
- Alarm management
- Trend logging
- Equipment status monitoring
- Smoke control monitoring and control interfaces.

b. Mechanical Equipment Controls:

Mechanical equipment and devices that the BAS/BMS controls in the terminal building include the following:

- 222 VAV and fan-powered terminal units throughout the facility.

- 22 AHU/DX/UNT control applications.
- 21 smoke control and life-safety control panels serving smoke dampers, air-handling systems, and exhaust systems associated with the terminal smoke management strategy.

Mechanical Equipment and devices that the BAS/BMS controls in the Airfield Rescue Fire Fighting (ARFF) and Maintenance facility includes the following:

- 16 terminal units.
- Multiple AHU/DX control systems.
- A dedicated supervisory controller supporting local HVAC operation.

Many of the existing central equipment applications utilize legacy Johnson Controls DX-9100 controllers and early-generation UNT controllers. These controllers are interconnected through N2 communication trunks that are routed throughout the airport via existing conduit systems.

c. Smoke Control System:

The airport BAS performs a critical role in smoke control operation and is integrated with the facility fire alarm and smoke management systems. Existing smoke control functions include:

- Smoke damper operation and monitoring
- Exhaust fan control
- Supply and return air shutdown sequences
- Fire alarm interface functions
- Smoke control room operation
- Life-safety air handling unit control

Numerous existing smoke-control-related control panels contain legacy Johnson Controls hardware and support UL 864 life-safety applications. These panels are distributed throughout the terminal and are connected to supervisory-level controllers for monitoring and sequence execution.

d. Terminal Unit Controls:

The BAS presently serves approximately 222 fan-powered and cooling-only VAV terminal units located throughout passenger waiting areas, airline offices, administration spaces, baggage handling areas, concourses, ticketing areas, TSA spaces, observation areas, and support spaces. The existing terminal units are controlled through legacy VMA and N2-based control hardware utilizing wall-mounted room sensors/thermostats. The terminal unit control network includes:

- Zone temperature monitoring
- Airflow control
- Fan-powered box operation
- Reheat control where applicable
- Occupied/unoccupied scheduling
- Alarm reporting to the supervisory system.

e. Communications Infrastructure:
The field-level control network is primarily based on Johnson Controls N2 communications technology. The N2 network connects legacy terminal unit controllers, DX controllers, and other field devices to the supervisory network. The existing communication architecture includes:

- Multiple N2 trunks throughout the terminal
- Field devices connected through existing conduit infrastructure
- Distributed field control panels
- Supervisory integration through NAE controllers.

Due to the age of the N2 architecture and associated controller hardware, long-term supportability, parts availability, cybersecurity compliance, and future expandability are becoming increasingly challenging.

f. Existing System Limitations
Several components of the existing BAS have reached functional or technological obsolescence, including:

- Johnson Controls NAE55 supervisory controllers
- DX-9100 application-specific controllers
- UNT controllers
- Legacy N2 communication infrastructure
- Existing VAV terminal unit controls and sensors
- Existing smoke control panels and associated controller hardware.

The existing sequences of operation remain functional and are intended to be replicated. BAS/BMS distributed field components or devices that may be identified as malfunctioning during the progression of the work shall be replaced under a negotiated additional work agreement through this contract or otherwise arranged by the Owner, as required to facilitate the operation of the new HVAC systems

14. Existing Building Power Distribution to HVAC Equipment
The electrical power for the HVAC equipment to be replaced as part of this project is routed from the switchgear in the main terminal electrical room(s) and from the power distribution panelboards located in the Pedestrian Bridge electrical rooms. The electrical SINGLE LINE DIAGRAM drawings for the existing power circuit conditions for each HVAC unit are included in Appendix-A. These drawings are provided for the Design-Builder's use in Proposal pricing and final design reference purposes only.

The Design-Builder shall verify the existing conditions as necessary for the Proposal price submittal to include all required work in the price, and prior to preparing final design details and drawings for construction use.

15. Existing Building Roofing Systems

The areas where the HVAC equipment replacement work will occur have varying types and ages of existing roofing materials. The existing roofing conditions are generally as follows:

1. Terminal building low (valley) roof where AHU-5 is located is light gray TPO roofing installed in 1998.

2. Terminal building low (valley) roof where AHU-6 and AHU-7 are located is light gray TPO roofing installed in 2003. This area is adjacent/contiguous to the AHU-5 area.

3. Terminal Building low (valley) roof adjacent/contiguous to the AHU-5 area where AHU-3/4 is located is light gray TPO roofing installed in 2015 (still under warranty).

4. Terminal Walkway (Pedestrian Bridge) roof where RTU-1 through RTU-5 are located is black EPDM roofing installed in 2000.

For additional existing roofing information related to each area refer to the prior projects roofing specifications (designated by year of installation) included in Appendix A.

AIRPORT TERMINAL & WALKWAY - HVAC REPLACEMENT PROJECT ; EXISTING EQUIPMENT DATA TABLE

Unit Name	Install Date	Location	Area Served	Mfr.	Model	Serial	Cooling	Refrigerant	Heating	Fuel	Type	Unit Airflow CFM
AHU-5	1998	Terminal Roof	Gate 5-8	Haakon	Pentpak	98-6135-01	184 Tons DX	R22	2625 MBH	Building Hot Water	VAV	50000
AHU-6	1998	Terminal Roof	Gate 1-5	Haakon	Pentpak	98-6135-02	134 tons DX	R22	1950 MBH	Building Hot Water	VAV	36000
AHU-7	2003	Terminal Roof	Gate 1-5	Mammoth	CDHBEFP-1703-W1815-811-VAV	%ULLINE00169100	184 Tons DX	R22	3240 MBH	Building Hot Water	VAV	60000
RTU-1	2000	Terminal Walkway Roof	Ped. bridge	York	D2CG07209946A	NBJM021550	6 TONS DX	R22	125000 BTUH	Nat. Gas	Constant	2200
RTU-2	2000	Terminal Walkway Roof	Ped. bridge	York	D2CG240N32046EF	NEJM068204	20 Tons DX	R22	320000 BTUH	Nat. Gas	Constant	7500
RTU-3	2000	Terminal Walkway Roof	Ped. bridge	York	D2CG240N32046ECF	NEJM068203	20 Tons DX	R22	400000 BTUH	Nat. Gas	Constant	7000
RTU-4	2000	Terminal Walkway Roof	Ped. bridge	York	D2CG240N32046ECF	NEJM067082	20 Tons DX	R22	400000 BTUH	Nat. Gas	Constant	6300
RTU-5	2000	Terminal Walkway Roof	Ped. bridge	York	D400150N20046ST0	NCJM031267	12.5 Ton DX	R22	200000 BTUH	Nat. Gas	Constant	4500



I. EQUIPMENT LAYOUT

The new HVAC equipment will be installed at the same locations as the existing equipment.

The HVAC GENERAL SITE PLAN is provided in Appendix-A.

ENLARGED HVAC PLANS of the specific areas local to each HVAC unit to be replaced, with additional project information indicated, are also provided in Appendix-A.

J. MECHANICAL WORK

Refer to the requirements of the GENERAL CONSTRUCTION SPECIFICATIONS, Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), including the HVAC Equipment Performance Specifications, and all applicable requirements described in the preceding sections of this specification. All mechanical systems design, equipment procurement, fabrication, installation, testing, and commissioning shall be performed in accordance with recognized industry standards, accepted engineering practices, and all applicable codes, regulations, and authority having jurisdiction (AHJ) requirements.

K. ELECTRICAL WORK

Refer to the requirements of the GENERAL CONSTRUCTION SPECIFICATIONS, Division 26 – Electrical, including applicable provisions contained in the Division 23 – Heating, Ventilating, and Air Conditioning (HVAC) Equipment Performance Specifications, as well as the scope of work and other requirements identified in the preceding sections of this specification. All electrical design, equipment, materials, installation, and construction activities shall be performed in accordance with recognized industry standards, accepted engineering practices, and applicable codes and regulations.

L. STRUCTURAL & ROOFING / FLASHING WORK

Structural work required by the Design-Builder's Technical Construction Approach shall comply with all applicable building code requirements. Refer to the GENERAL CONSTRUCTION SPECIFICATIONS, Division 07 – Thermal and Moisture Protection, for roofing performance requirements; the HVAC Equipment Performance Specifications in Division 23 – Heating, Ventilating, and Air Conditioning (HVAC), for related requirements for structural supports, equipment curbs, and flashings; and the scope of work and other requirements described in the preceding subsections of this specification. All structural, roofing, and flashing design and construction work shall be performed in accordance with applicable codes, industry standards, and best practices.

M. STANDARDS

The Design-Builder shall perform all mechanical, electrical, structural, and roofing/flashing design and construction activities in accordance with the requirements of the Contract Documents and all applicable standards, design codes, manuals, and regulations referenced therein, including the New Hampshire Building Code, unless more stringent requirements are specified in the Standard Specifications or Project Specifications.

All design, materials, equipment, workmanship, and installation required under the Project Documents shall comply with all applicable federal, state, and local laws, codes, regulations, ordinances, and governing authority requirements in effect at the time of construction.

In the event of any discrepancy, conflict, or ambiguity among applicable codes, standards, drawings, specifications, or other Contract Documents, the Design-Builder shall promptly notify the Airport and obtain written clarification or direction before proceeding with the affected work.

N. DESIGN CRITERIA

Design Criteria shall be in accordance with the Technical Specification Sections including equipment performance specifications, Volume II Airport Standard Specifications, and other sections of the Contract Documents including the State of New Hampshire Building Code, and all applicable Federal Aviation Administration (FAA) Advisory Circulars (AC).

O. JOB CONDITIONS

The Design-Builder shall make necessary provisions to protect existing facilities and systems from damage, deterioration, and environmental conditions.

Prior to any modification, coordinate any temporary work or alterations required with the Airport.

Refer to Volume II Airport Standard Specifications, and other sections of the Contract Documents for applicable information.

P. SUBMITTALS

Design-Builder to provide product data submittals and design / construction drawings no later than the period designated by the Contract Documents after receiving Notice to Proceed from the Owner. All final construction issue and as-built structural, mechanical,

electrical, plumbing, system modification installation drawings are to be signed and sealed by a Professional Engineer licensed in the State of New Hampshire as applicable.

Design-Builder shall submit a letter from the equipment manufacturers indicating that the Installer is approved and authorized by the Manufacturer for the installation of the equipment as specified.

Submittals shall be in accordance with the requirements of the Technical Specifications Sections requirements, the Volume II Airport Standard Specifications General Conditions Section 01300 requirements, and other applicable sections of the Contract Documents. Submittals and drawings shall include, but are not limited to, the following:

1. Product Data:
    a. Equipment Manufacturer's catalogue cutsheets, and equipment order data
    b. Equipment Manufacturer's custom packaged unit diagrams & drawings as proposed for this project (pre-order status - for Airport's approval & fabrication release)
    c. Equipment performance data sheets.
    d. Product Data Sheets for manufactured products and materials to be incorporated into the Work
    e. Electrical characteristics and connecting requirements of equipment and devices.
    f. All proprietary equipment information shall be clearly identified in the literature and manuals.
2. Design, Layout, and Construction Drawings.
3. Shop Drawings.
4. Record Drawings.
5. Operation and Maintenance Manuals - provide three (3) hard-bound copies with an electronic (pdf) copy on a CD/DVD included with each bound manual:
    a. Complete table of contents.
    b. Complete instructions regarding operation and maintenance of equipment.
    c. Complete illustrated and annotated exploded views of all assemblies as well as a complete and illustrated exploded view for identifying all system parts.
    d. Complete nomenclature of replaceable parts, part numbers. If product source is another vendor, Design-Builder shall include name and address of the other vendor.
    e. Sample copies of a preventive maintenance chart.
    f. Descriptions of safety devices.

g. Safety rules, tests, and procedures, including testing of all systems and subsystems.

h. Troubleshooting techniques.

i. Control and schematic electrical wiring diagrams for control cabinet.

j. Detailed lubrication and cleaning schedule indicating weekly, monthly, quarterly, semiannual, and annual lubrication; and a description of each lubrication point, lubrication type, and specification.

k. Complete detailed drawings and wiring diagram of fault-finding device(s).

6. Certification:

a. Design-Builder shall provide certification in the Proposal that the Airport will be provided with copies of all documents related to maintenance, safety, operations, design changes, modifications, retrofits, etc., which relate to any part, component, equipment, system, subsystem, or material and services applicable to the specified equipment.

b. All of the above-referenced documents shall be provided as they pertain to the original installation and for a period of ten (10) years after final acceptance of the equipment.

c. Provide all material on DVD/CD and one (l) hardcopy, and electrically transmitted in a format and delivery platform approved by the Airport.

7. Safety Data Sheets (SDS):

a. SDS and product data sheets shall be submitted with an index listing each product.

Q. PRODUCT DELIVERY, STORAGE AND HANDLING

1. Design-Builder shall coordinate delivery to the site, or other storage area acceptable to the Airport, and provide adequate secured storage acceptable to the Manufacturer and Installer. Stored material and equipment shall be insured as required by the Contract Documents.

2. Deliver components with factory-installed wooden skids and lifting lugs, and pack components in factory-fabricated weather-tight protective containers.

3. Store materials in original protective packaging in a dry area and protected from weather prior to delivery to site.

4. Protect equipment and exposed finishes during transportation, storage and erection against damage and stains. Equipment and materials shall be inspected upon arrival at the site by the Design-Builder for damage or other defects. The Design-Builder shall immediately bring any issues to the attention of the Owner's Representative. The Owner's Representative may inspect the equipment or material at any time onsite prior to acceptance for damage or defects. Damaged or otherwise unsatisfactory and/or non-

compliant equipment or material shall be replaced or repaired/corrected at the discretion and approval of the Owner.

5. Handle components carefully to avoid damage to components, enclosures, and finish.

R. WARRANTY

1. The Design-Builder shall ensure all manufacturers warrant their products and associated hardware to be free of defects in material and workmanship for a minimum period of one (1) year from the date of construction acceptance / commissioning.
2. Additional special warranty requirements are stipulated in the Technical Specification Sections.
3. Any defect in the new Work found within the warranty period shall be repaired or replaced by the Design-Builder, at total cost to the Design-Builder including labor, parts, incidentals, and transportation, and no additional cost to the Owner.
4. After the Work has been deemed Substantially Complete by the Airport, the Design-Builder shall provide letters to the suppliers with copies to the Airport, identifying Substantial Completion Date established by the Airport and therefore the date that the Warranty shall begin. Prior to release of final payment, Certificates of Warranty shall be provided to the Airport by the Design-Builder for the overall project and for the individual Equipment Manufacturers.
5. Refer to Project Documents Volume II - Airport Standard Specifications - General Conditions Section 01740 for additional Warranty information.

PART 2. PRODUCTS

2.1 PRODUCT AND PERFORMANCE REQUIREMENTS

See the applicable sections of the Technical Specifications, Standard Specifications, and Federal Contract Requirements.

PART 3. EXECUTION

3.1. EXAMINATION

A. Design-Builder shall examine the existing conditions at the site and the installation of existing equipment as described elsewhere in these Specifications and the Contract Documents.

3.2. INSTALLATION

A. Design-Builder shall install equipment in accordance with the equipment manufacturers' guidelines and instructions. Design-Builder shall include onsite representation from each equipment supplier(s) for guidance and proper installation procedures and testing / commissioning and additionally, as may be necessary, to resolve any operation issues before the date of commissioning.

B. Refer to the Equipment Performance Specifications and General Trade Specifications for additional installation and construction requirements.

C. As a condition of project completion acceptance and final payment, the Design-Builder shall provide As-Built (Record Status) drawings for all the work performed to the Airport.

3.3. PERMITS & BUILDING CODE REQUIREMENTS

A. The Airport, owned and operated by the City of Manchester Department of Aviation (DOA), is located partially in the City of Manchester and partially in the Town of Londonderry, and is a self-inspecting entity under an intermunicipal agreement (IMA) between the two municipalities. Building permit applications through the municipalities' individual building departments are not required for this project, however, Airport approval of final design plans, details, and specifications is required. Airport approval of construction materials product data submittals is also required.

   The Airport Building Superintendent is the general construction inspecting authority, and the Londonderry Fire Department is the Authority Having Jurisdiction (AHJ) for building fire alarm & life-safety systems test/inspections. The Design-Builder shall coordinate with the Airport (Owner) and the Airport's Project Representative / Engineer, to arrange for appropriate inspections prior to enclosing any construction work that requires inspection or acceptance for Code and Contract / Specifications compliance or other applicable reasons. Failure to coordinate in advance may result in re-opening of enclosed work for inspection.

B. The performance of all work, including design and construction, shall conform to the applicable design and building construction codes and all federal, state, local laws and pertinent ordinances including but not limited to the State of Hampshire Building Code (TITLE XII, PUBLIC SAFETY AND WELFARE, RSA Chapter 155-A) latest edition.

3.4. FIELD QUALITY CONTROL

A. Design-Builder shall perform equipment quality control tests as required and recommended by Original Equipment Manufacturer (OEM) guidelines before permitting initial installation / startup / use.

B. Advise the Airport, and AHJs (as applicable) in advance of dates and times that tests are to be performed such that attendance may be coordinated.

C. Factory Testing: Factory Acceptance Testing (FAT) per OEM's recommendations and performance requirements. The Airport's Representatives shall be provided with 30-day advanced notice and opportunity to attend the FAT. Contractor shall coordinate with and between the Equipment Manufacturer and the Project Representative accordingly.

D. Operating Site Test: To be performed by certified OEM representatives and witnessed by Airport Representatives and Design-Builder / Engineer of Record.

3.5. ACCEPTANCE REVIEW AND TESTS / COMMISSIONING

A. Acceptance Testing / Commissioning shall be in accordance with the requirements of the Technical Specifications Sections, Volume II Airport Standard Specifications, and the Manufacturer's recommendations. Final Commissioning shall be performed by an Owner-approved qualified Independent 3rd-Party Commissioning Consultant / Firm to be hired and coordinated by the Design-Builder. Commissioning shall be witnessed by Airport Project Representatives, certified OEM representatives, and the Design-Builder / Engineer of Record. Costs for the commissioning and preparation of a Commissioning Report by the 3rd-Party Commissioning Consultant / Firm shall be included in the Design-Builder's Proposal price.

B. Design-Builder shall perform review and evaluation of all aspects of its work prior to requesting Airport's final review. Work shall be considered ready for Airport's final contract compliance review when all Design-Builder's tests are complete, and all elements of work or a designated portion thereof are in place and deemed ready for service as intended.

C. Design-Builder to provide all equipment and instruments necessary to perform required tests.

D. Testing, Adjusting, and Balancing of the full system affected by this work shall be performed prior to final commissioning by a NEBB/AABC Certified independent Test-Adjust-Balance (TAB) Firm to be hired by the Design-Builder and approved by the Owner. Testing, adjusting, and balancing shall be in accordance with equipment manufacturer recommendations, parameters established by the final design, and industry requirements and best practices. The project-specific air and hydronic (water-glycol) testing / adjusting / balancing procedures to be prepared by the TAB Contractor shall be submitted, along with proof of certification, to the Owner for review at least 30 days prior to performance of the work.

E. Design-Builder to coordinate with the Airport in advance of testing and schedule testing to allow the Owner's Representative(s) to witness the testing and subsequently furnish all

test results in writing to the Airport for record, in the form of Commissioning Reports and Air Flow Test & Balancing Reports for each HVAC Unit / system.

3.6. DEMONSTRATION & TRAINING

A. Engage a factory-authorized service representative to train the Airport's maintenance personnel to operate and maintain the equipment and systems installed to the extent recommended by the Manufacturer(s). Two separate identical training sessions shall be planned to be a minimum of eight (8) hours in duration.

B. Check operation of each piece of equipment with the Airport's personnel present before date of Commissioning and Substantial Completion. Determine that operation of systems and devices are functioning properly.

END OF SECTION 00 20 00

SECTION P - 23 09 23.01

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Direct digital control (DDC) system equipment and components for monitoring and controlling of HVAC, exclusive of instrumentation and control devices.

2. This work shall be included in the contract Base Bid for equipment replacement.

3. This equipment specification is a performance-based specification that establishes minimum requirements and expectations for final design and construction by the Design-Builder. The capacities of the equipment shall be verified by the final design as described in Section 00 20 00 Scope of Work. Before release of equipment procurement orders, the final equipment selections, specifications, drawings, and manufacturer's project-specific data sheets shall be submitted to the Owner for review and approval. Proposed equipment shall conform to the requirements of this Section unless otherwise approved by the Owner.

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.

D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable application controllers, and application-specific controllers.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

J. E/P: Voltage to pneumatic.

K. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

N. I/P: Current to pneumatic.

O. LAN: Local area network.

P. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

Q. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

R. Modbus TCP/IP: An open protocol for exchange of process data.

S. MS/TP: Master-slave/token-passing, ISO/IEC/IEEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

T. MTBF: Mean time between failures.

U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

W. Peer to Peer: Networking architecture that treats all network stations as equal partners.

X. POT: Portable operator's terminal.

Y. RAM: Random access memory.

Z. RF: Radio frequency.

AA. Router: Device connecting two or more networks at network layer.

BB. Server: Computer used to maintain system configuration, historical and programming database.

CC. TCP/IP: Transport control protocol/Internet protocol.

DD. UPS: Uninterruptible power supply.

EE. USB: Universal Serial Bus.

FF. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

GG. VAV: Variable air volume.

HH. WLED: White light emitting diode.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.4 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.

3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
    a. Gateways.
    b. Routers.
    c. Protocol analyzers.
    d. DDC controllers.
    e. Enclosures.
    f. Electrical power devices.
    g. UPS units.
    h. Accessories.
    i. Instruments.
    j. Control dampers and actuators.
    k. Control valves and actuators.

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. Shop Drawings:

1. General Requirements:

    a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
    b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
    c. Drawings Size: 11x17

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following if applicable:

    a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop workstation network port, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
    d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    e. Network communication cable and raceway routing.
    f. Information, drawn to scale,
    g. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

    a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
    b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
    c. A graphic showing location of control I/O in proper relationship to HVAC system.
    d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
    e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
    f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
    g. Narrative sequence of operation.
    h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

    a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
    b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
    c. Front, rear, and side elevations and nameplate legend.
    d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

    a. Each device connected to network with unique identification for each.
    b. Interconnection of each different network in DDC system.

c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches, and transmitters.
d. Process signal tubing to sensors, switches, and transmitters.

10. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
c. Intended operator access between related hierarchical display screens.

D. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies, and related devices provided or modified under this Contract, where applicable.
2. Complete listing and description of each report, log and trend for format and timing, and events provided or modified under this Contract, where applicable.
3. System and product operation under each potential failure condition including, but not limited to, the following:

a. Loss of power.
b. Loss of network communication signal.
c. Loss of controller signals to inputs and outpoints.
d. Network failure.
e. Controller failure.
f. Instrument failure.
g. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

E. Delegated Design Submittals: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.

2. Schedule and design calculations for control dampers and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Face velocity at Project design and minimum airflow conditions.
    c. Pressure drop across damper at Project design and minimum airflow conditions.
    d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    e. Maximum close-off pressure.
    f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close, or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Pressure-differential drop across valve at Project design flow condition.
    c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    d. Design and minimum control valve coefficient with corresponding valve position.
    e. Maximum close-off pressure.
    f. Leakage flow at maximum system pressure differential.
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

    a. Instrument flow range.
    b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.
    c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.
    d. Pressure-differential loss across instrument at Project design flow conditions.
    e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

B. Product Certificates:

1. Data Communications Protocol Certificates:

a. Certifying that each proposed DDC system component complies with ASHRAE 135.

C. Test and Evaluation Reports:

1. Product Test Reports: For each product, for tests performed by a qualified testing agency

D. Source Quality-Control Submittals:

1. Source quality-control reports.

E. Field Quality-Control Submittals:

1. Field quality-control reports.

F. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system.

1. In addition to items specified in "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.7 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of 5 years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least 3 past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing, and quality control.
    d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
    e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 50 miles> of Project.
3. Demonstrate past experience with installation of DDC system products being installed for period within 3 consecutive years before time of bid.
4. Demonstrate past experience on 5 projects of similar complexity, scope, and value.
5. Demonstrate past experience of each person assigned to Project.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support ongoing DDC system operation for a period of not less than 5years after Substantial Completion.

9. DDC system manufacturer's backing to take over execution of the Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Perform warranty service during normal business hours and commence within 8 hours of Owner's warranty service request.
2. Warranty Period: 2 year(s) from date of Substantial Completion.

a. For Gateway: 2 year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Johnson Controls Inc
2. Approved Equal

2.2 EXISTING DDC SYSTEM DESCRIPTION

The Airport's BAS/BMS-controlled conditioned facilities include the Terminal Building, Terminal Access Walkway (Pedestrian Bridge), and Airfield Rescue Fire Fighting and Maintenance (ARFF) Building. These facilities are currently served by an existing Johnson Controls Metasys (7.0) Building Automation System consisting primarily of legacy Johnson Controls N2 proprietary communication networks with portions of BACnet MS/TP infrastructure installed during previous renovation projects. BAS architecture, graphics, schedules, alarms, trends, databases, and operator interfaces shall remain fully operational throughout construction.

Provide all controls, controllers, programming, graphics modifications, communication interfaces, integration services, and related work required to integrate HVAC equipment furnished under this Contract into the existing BAS.

New HVAC equipment controllers shall communicate with and be integrated into the existing Metasys system using the existing N2 network unless otherwise approved by the Owner.

BAS/BMS INTEGRATION REQUIREMENTS

Controllers provided under the Project shall be current-generation products compatible with the existing Metasys architecture and suitable for future migration to BACnet-based system architecture. Field devices, sensors, actuators, control valves, damper actuators, and associated control wiring installed shall be reusable under future BAS/BMS modernization efforts.

Existing VAV Terminal Units

Existing terminal units serving the Terminal Building and ARFF Building are being maintained by the Owner and shall be presumed operational for the purposes of Proposal pricing.

Except where specifically required for connection, testing, startup, and integration of HVAC equipment installed under this Contract, replacement of existing VAV controllers, sensors, actuators, or terminal unit control components shall not be included in the Base Bid.

Any deficiencies identified in existing VAV terminal unit controls that are unrelated to the Work of this Contract shall be reported to the Owner.

Known Access Constraints

Certain existing VAV terminal unit locations are situated above high ceiling spaces where access may require manlift equipment for balancing access. Known locations include:

1. Approximately fourteen (14) terminal units above the high ceiling areas in Bag Claim 1 and Bag Claim 2.

These locations are identified for bidder awareness only and shall be verified by the Design-Builder.

2.2.2 PERFORMANCE REQUIREMENTS

DDC system shall monitor and control roof top units as indicated

A. Delegated Design, Qualified Professional Engineer:

B. Delegated Design, Qualified Professional: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system manages HVAC systems.
b. DDC system operates HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system responds to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system operates while unattended by an operator and through operator interaction.

C. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths complying with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 less.
2. Smoke-Developed Index: 50 or less.

D. DDC System Speed:

1. Response Time of Connected I/O:

a. Update AI point values connected to DDC system at least every 5 seconds for use by DDC controllers. Points used globally to also comply with this requirement.
b. Update BI point values connected to DDC system at least every 5 seconds for use by DDC controllers. Points used globally to also comply with this requirement.
c. AO points connected to DDC system to begin to respond to controller output commands within 2 second(s). Global commands to also comply with this requirement.
d. BO point values connected to DDC system to respond to controller output commands within 2 second(s). Global commands to also comply with this requirement.

E. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Flow:

a. Air: 5 percent of design flow rate.
b. Air (Terminal Units): Within 10 percent of design flow rate.

2. Moisture (Relative Humidity):

a. Air: Within 5 percent RH.

3. Pressure:

a. Air, Ducts and Equipment: 1 percent of instrument range
b. Space: Within 1 percent of instrument range
c. Water: Within 1 percent of instrument 1range11

4. Temperature, Dew Point:

a. Air: Within 1 deg F

5. Temperature, Dry Bulb:

a. Air: Within 1 deg F
b. Space: Within 1 deg F

6. Temperature, Wet Bulb:

    a. Air: Within1 deg F

F. Control Stability: Control variables indicated within the following limits:

1. Flow:

    a. Air, Ducts and Equipment, except Terminal Units: Within 5 percent of design flow rate.
    b. Water: Within 5 percent of design flow rate.

2. Moisture (Relative Humidity):

    a. Air: Within 5 percent RH.

3. Level: Within 5 percent of reading.
4. Pressure:

    a. Air, Ducts and Equipment: 1 percent of instrument range 1 percent of instrument range
    b. Water: Within 1 percent of instrument range

5. Temperature, Dry Bulb:

    a. Air: Within 2 deg F
    b. Heating Hot Water: Within 2 degree F

6. Temperature, Wet Bulb:

    a. Air: Within 2 deg F

G. Environmental Conditions for Controllers:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

    a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

    a. Outdoor-mounted controllers and devices shall be housed in Type 4 enclosures or manufacturer's listed enclosure suitable for the installed environment location.

Where environmental conditions exceed equipment operating limits, provide protective enclosures, heating, ventilation, or cooling as required by the manufacturer.

H. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:
   a. Outdoors, Unprotected: Type 4

2.3 NETWORK COMMUNICATION PROTOCOL

2.4.1. Base Bid

1. The existing Johnson Controls Metasys BAS consists of a combination of legacy N2 Open and BACnet MS/TP networks.

2. Existing BAS architecture and communication infrastructure shall remain operational throughout construction.

3. New controllers furnished under Part A shall integrate with the existing BAS utilizing the existing N2 Open network architecture unless otherwise approved by the Owner.

4. Controllers shall be current generation products suitable for future migration to BACnet MS/TP and/or BACnet/IP architecture as part of a future BAS modernization effort.

5. Replacement of terminal-wide communications trunks, backbone cabling, or network infrastructure is not required under Part A except as necessary to connect new equipment.

2.4.3 PROGRAMMING SOFTWARE

1. Include programming software to execute sequences of operation indicated.

2. Include programming routines in simple and easy-to-follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.

2.4 DDC CONTROLLERS

A. DDC system consisting of a combination of network controllers, programmable application controllers, and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers to perform monitoring, control, energy optimization, and other requirements indicated.

C. DDC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller is capable of full and complete operation as a completely independent unit and as a part of DDC system wide distributed network.

E. Controllers used for smoke-control applications shall be listed and labeled in accordance with UL 864.

F. Controller shall be provided with a field-selectable switch or configuration setting enabling communication using either Johnson Controls N2 Open or BACnet MS/TP protocol.

G. Environment Requirements:

1. Controller hardware suitable for anticipated ambient conditions.
2. Controllers located in conditioned space rated for operation at 32 to 120 deg F
3. Controllers located outdoors rated for operation at -40 to 150 deg

H. Power and Noise Immunity:

1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

I. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

    a. Network Controllers: 60 percent.
    b. Programmable Application Controllers: Not less than 70 percent.
    c. Application-Specific Controllers: 80 percent.

2. Memory for DDC controller's operating system and database are to include the following:

    a. Monitoring and control.
    b. Energy management, operation, and optimization applications.
    c. Alarm management.
    d. Historical trend data of all connected I/O points.
    e. Maintenance applications.
    f. Operator interfaces.
    g. Monitoring of manual overrides.

J. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:

    a. 20 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: 2
        2) AOs: 2
        3) BIs: 3
        4) BOs: 3
        5) Option to provide universal I/O to meet spare requirements.

2. Programmable Application Controllers:

    a. 10 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: 2
        2) AOs: 2
        3) BIs: 3.
        4) BOs: 3
        5) Option to provide universal I/O to meet spare requirements.

3. Application-Specific Controllers:

    a. 10 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: 2
        2) AOs: 2
        3) BIs: 3
        4) BOs: 3
        5) Option to provide universal I/O to meet spare requirements.

K. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

L. I/O Point Interface:

1. Connect hardwired I/O points to network, programmable application, and application-specific controllers.
2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.

4. AIs:

    a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
    b. Compatible with, and field configurable to, sensor and transmitters installed.
    c. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
    d. Signal conditioning including transient rejection for each AI.
    e. Capable of being individually calibrated for zero and span.
    f. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
    g. External conversion resistors are not permitted.

5. AOs:

    a. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
    b. Output signals range of 4 to 20 mA dcor]0 to 10 V dc as required to include proper control of output device.
    c. Capable of being individually calibrated for zero and span.
    d. Drift is to be not greater than 0.4 percent of range per year.
    e. External conversion resistors are not permitted.

6. BIs:

    a. Accept contact closures and ignore transients of less than 5 ms duration.
    b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
    c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
    d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
    e. Pulse accumulation input points complying with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.

7. BOs:

    a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.

        1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
        2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
        3) Minimum contact rating to be 1 A at 24 V ac.
        4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.

b. Include BOs with two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs to be selectable for either normally open or normally closed operation.
d. Include tristate outputs (two coordinated BOs) for control of three-point, floating-type electronic actuators without feedback.

2.5 NETWORK CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Include enough memory to support its operating system, database, and programming requirements with spare memory indicated.
4. Share data between networked controllers and other network devices.
5. Operating system of controller to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Include network controllers with a real-time clock.
7. Controller to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller is to assume a predetermined failure mode and generate an alarm notification.
8. Make controllers fully programmable.

B. Communication:

1. Network controllers communicate with other devices on DDC system level 1 network.
2. Network controller to also perform routing if connected to network of programmable application controllers and application-specific controllers.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop operator's workstation.
2. Local Keypad and Display:

a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display requires a security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

3. Maintain Basic Input Output System (BIOS) and programming information in event of power loss for at least72> hours.

2.6 PROGRAMMABLE APPLICATION CONTROLLERS

A. General:

1. Include adequate number of controllers to achieve performance indicated.
2. Provide enough memory to support its operating system, database, and programming requirements with spare memory indicated.
3. Share data between networked controllers and other network devices.
4. Include controller with operating system to manage I/O communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Include controllers with a real-time clock.
6. Controller is to continually check status of its processor and memory circuits. If an abnormal operation is detected, controller assumes a predetermined failure mode and generates an alarm notification.
7. Fully programmable.

B. Communication:

1. Programmable application controllers are to communicate with other devices on network.

C. Operator Interface:

1. Equip controllers with a service communications port for connection to desktop operator's workstation
2. Local Keypad and Display:

    a. Equip controller with local keypad and digital display for interrogating and editing data.
    b. Protect use of keypad and display by security password.

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain BIOS and programming information in event of power loss for at least 72 hours.

2.7 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment or system. Controllers are not fully user-

programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and continued control functions without being connected to network.
2. Share data between networked controllers and other network devices.

B. Communication: Application-specific controllers are to communicate with other application-specific controllers and devices on network, and to programmable application controllers and network controllers.

C. Operator Interface: Equip controllers with a service communications port for connection to desktop workstation

D. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.8 CONTROLLER SOFTWARE

A. General:

1. Software applications are to reside and operate in controllers. Edit applications through operator workstations
2. Identify I/O points by up to [**30**character point name and up to 16character point descriptor. Use same names throughout, including at operator workstations.
3. Execute control functions within controllers using DDC algorithms.
4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Secure operator access using individual security passwords and user names.
2. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
3. Record operator log-on and log-off attempts.
4. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:

1. Weekly Schedule:

    a. Include separate schedules for each day of week.
    b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.
    c. Each schedule may consist of up to 10 events.
    d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

    a. Include ability for operator to designate any day of the year as an exception schedule.
    b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

    a. Include capability for operator to define up to 99 special or holiday schedules.
    b. Place schedules on scheduling calendar with ability to repeated each year.
    c. Operator able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Include operator with a method of grouping together equipment based on function and location.
3. Include groups that may be for use in scheduling and other applications.

E. Binary Alarms:

1. Set each binary point to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Provide each analog object with both high and low alarm limits.
2. Include capability to automatically and manually disable alarming.

G. Alarm Reporting:

1. Include ability for operators to determine action to be taken in event of an alarm.
2. Route alarms to appropriate operator workstations based on time and other conditions.
3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.

H. Remote Communication:

1. Include ability for system to notify operators by phone message, text message, and email in event of an alarm.

I. Maintenance Management: Monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

J. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

K. Control Loops:

1. Support any of the following control loops, as applicable to control required:

a. Two-position (on/off, open/close, slow/fast) control.
b. Proportional control.
c. Proportional plus integral (PI) control.
d. Proportional plus integral plus derivative (PID) control.

1) Include PID algorithms with direct or reverse action and anti-windup.
2) Algorithm to calculate a time-varying analog value used to position an output or stage a series of outputs.
3) Make controlled variable, set point, and PID gains operator-selectable.

e. Adaptive (automatic tuning).

L. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.

M. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include algorithm that calculates a sliding-window average (rolling average). Make algorithm flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include algorithm that calculates a fixed-window average. Use a digital input signal to define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

N. Anti-Short Cycling:

1. Protect BO points from short cycling.
2. Feature to allow minimum on-time and off-time to be selected.

O. On and Off Control with Differential:

1. Include algorithm that allows BO to be cycled based on a controlled variable and set point.
2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.

P. Run-Time Totalization:

1. Include software to totalize run-times for all BI points.
2. Assign a high run-time alarm, if required, by operator.

2.9 ENCLOSURES

A. General:

1. House each controller and associated control accessories in single enclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
2. Do not house more than one controller in single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
6. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install maximum of two wires on each side of terminal.
9. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).

12. Include products mounted in enclosures with engraved nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch- (6-mm-) high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.
14. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 15 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction, and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Accessories:

1. Electric Heater:

    a. Aluminum housing with brushed finish.
    b. Thermostatic control with adjustable set point from 0 to 100 deg F (minus 18 to 38 deg C).
    c. Capacity: 100, 200, 400, and 800 W, as required by application.
    d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:

    a. Number and size of fans, filters, and grilles, as required by application.
    b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
    c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.

d. Thermostatic control with adjustable set point from 32 to 140 deg F (0 to 60 deg C).
e. Airflow Capacity at Zero Pressure:

1) 4-Inch (100-mm) Fan: 100 cfm (47 L/s).
2) 6-Inch (150-mm) Fan: 240 cfm (113 L/s).
3) 10-Inch (250-mm) Fan: 560 cfm (264 L/s).

f. Maximum operating temperature of 158 deg F (70 deg C).
g. 4-inch (100-mm) fan thermally protected and provided with permanently lubricated ball-bearings.
h. 6- and 10-inch (150- and 250-mm) fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
i. Dynamically balanced impellers molded from polycarbonate material.
j. Fan furnished with power cord and polarized plug for power connection.
k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
l. Removable Intake and Exhaust Grilles: stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
m. Filters for NEMA 250, Type 1 Enclosures: Washable aluminum of size to match intake grille.
n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.

2.10 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum 16 AWG.
2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum 20 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:
   a. Twisted Pair: Black and white.
   b. Twisted Triad: Black, red, and white.
5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum 20 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:

    a. Twisted Pair: Black and white.
    b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

2.11 RACEWAYS

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.12 ACCESSORIES

A. Control Damper Blade Limit Switches:

1. Application: Sense positive open and/or closed position of damper blades.
2. NEMA 250, , oiltight construction. Install in instrument enclosure where required for additional environmental protection.
3. Arrange for mounting application, and to prevent "over-center" operation.

B. Manual Valves:

1. Brass Needle Valves:
    a. Pressure Rating: 150 psig (1030 kPa).
    b. Temperature Rating: 250 deg F (121 deg C).
    c. Body: Brass.
    d. Seat: Brass.
    e. Handle: Aluminum, brass, or stainless steel T-bar handle.
    f. Connections: Include tubing connections.
    g. Applications: Copper and polyethylene pneumatic tubing.

2. Bronze Body Ball Valves:
    a. Standard: MSS SP-110.
    b. SWP Rating: 150 psig (1035 kPa).
    c. CWP Rating: 600 psig (4140 kPa).
    d. Body Design: Two piece.
    e. Body Material: Bronze.
    f. Ends: Threaded.
    g. Seats: PTFE.
    h. Stem: Stainless steel.
    i. Ball: Stainless steel, vented.
    j. Handle: Stainless steel with vinyl grip.
    k. Port: Full.

2.13 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag bearing the following information:

    a. Service (Example): "Instrument Air."
    b. Pressure Range (Example): 0 to 30 psig (0 to 200 kPa).

2. Letter size minimum of0.25 inch high.
3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded blue with contrasting white center exposed by engraving through outer layer.
4. Include tag with brass grommet, chain, and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Self-adhesive label bearing unique identification.

    a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "HVAC Controls
3. For raceways housing pneumatic tubing, add phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least 0.25 inch (6 mm) beyond white border.

2.14 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate the following in accordance with industry standards for each product, and to verify DDC system reliability specified in performance requirements:

1. DDC controllers.
2. Gateways.
3. Routers.

B. Product(s) and material(s) will be considered defective if not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.
2. Equipment to Be Connected:
   a. Roof-top units specified in Section 237416.11 "Packaged, Small-Capacity, Rooftop Air-Conditioning Units."

b. Roof-top units specified in Section 237416.13 "Packaged, Large-Capacity, Rooftop Air-Conditioning Units."

3.2 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of other systems and equipment integration with DDC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.
2. Load software and demonstrate functional compliance with each control sequence of operation indicated.
3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:

   a. HVAC equipment controlled through DDC system, such as boilers, chillers, pumps, and air-handling units.
   b. Equipment faults and system recovery with fault annunciation.
   c. Analog and Boolean value alarming and annunciation.

4. Develop a method for testing interfaces before deployment.
5. Submit documentation supporting compliance upon request.

3.3 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control dampers, which are specified in Section 230923.12 "Control Dampers."
2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches, and transmitters.
4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
5. Liquid] temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."

6. Pipe- and tank-mounted thermowells, which are specified in Section 230923.16 "Gas Instruments."
7. Unit-mounted pressure sensors, switches, and transmitters, which are specified in

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

G. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

H. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

1. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems."
2. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.5 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply].

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of network controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.

F. Installation of Programmable Application Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of programmable application controllers to satisfy requirements indicated
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor, except where dedicated controllers are installed at terminal units.

G. Application-Specific Controllers:

1. DDC system provider and DDC system manufacturer to determine quantity and location of application-specific controllers to satisfy requirements indicated
2. For controllers not mounted directly on equipment being controlled, install controllers in a location that is easily accessible by operators.

3.6 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade to provide a fully functioning DDC system. Work is to comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

3.7 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install self-adhesive labels with unique identification on face for each of the following:
   1. Enclosure.
   2. Electrical power device.
   3. UPS unit.
   4. Accessory.

C. Install unique instrument identification for each instrument connected to DDC controller.

D. Install unique identification for each control damper and valve actuator connected to DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

   1. Permanently attach to equipment that can be automatically started by DDC control system.
   2. Locate where highly visible near power service entry points.

3.8 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

   1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
   2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
   3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
   4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

      a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

    a. Clamp cable over jacket in a junction box.
    b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.10 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic control dampers, verify that pressure gauges are provided in each air line connected to the damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment are secure.
6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic control valves, verify that pressure gauges are provided in each air line connected to the valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment are secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that valve ball, disc, or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments, verify the following:

    a. Sensing element type and proper material.
    b. Length and insertion.

3.11 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than 60 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.12 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.13 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller, and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.14 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
12. All I/O points are programmed into controllers.

13. Testing, adjusting, and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power
18. Meter, sensor, and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of DDC system and sequences of operation in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
6. Submit Test Plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. 24 hours after initial validation test, do as follows:

    a. Re-check I/O points that required corrections during initial test.

b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. 24 Hours after second validation test, do as follows:

   a. Re-check I/O points that required corrections during second test.
   b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

3.15 FINAL REVIEW

A. Submit written request to Engineer, Commissioning Agent and Construction Manager when DDC system is ready for final review. State the following:

1. DDC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

C. Prepare and submit closeout submittals when no deficiencies are reported.

3.16 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 **2** visits to Project during other-than-normal occupancy hours for this purpose.

3.17 MAINTENANCE SERVICE

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A. Beginning at Substantial Completion, verify that maintenance service includes 3months' full maintenance by DDC system manufacturer's authorized service representative. Include yearly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.18 SOFTWARE SERVICE AGREEMENT

Software service agreement with revisions and at least a 10 year lifespan on program

3.19 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

END OF SECTION P - 23 09 23.01

SECTION P - 23 73 43.19

OUTDOOR, CUSTOM PACKAGED AIR-HANDLING UNITS (AHU)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Outdoor, custom air-handling units with packaged refrigeration.

2. This equipment specification is a performance-based specification that establishes minimum requirements and expectations for final design and construction by the Design-Builder. The capacities of the equipment shall be verified by the final design as described in Section 00 20 00 Scope of Work. Before release of equipment procurement orders, the final equipment selections, specifications, drawings, and manufacturer's project-specific data sheets shall be submitted to the Owner for review and approval. Proposed equipment shall conform to the requirements of this Section unless otherwise approved by the Owner.

3. The term "Custom" means the unit shall take on the length, shape, aspect ratio, maximum weight, connection location and sizes, maintenance and access provisions, construction materials, cabinet ratings, and internal component performance, size and standard of quality as described on the plans, schedules and as specified herein. Unit shall not be limited to manufacturer's standard construction materials, components, predetermined sizes or performance of those features or parameters that deviate from these specifications.

4. Units shall be provided with stand-alone factory programmed DDC controls mounted and wired, and a BACnet MS/TP interface to the building automation system. The controller should be provided with a field-selectable switch or configuration setting enabling communication using either JCI N2 Open or BACnet MS/TP protocol. The controller shall be UL 864 listed if the unit is part of a smoke-control system.

B. Related Requirements:

1. Drawings and general provisions of the contract, including general and supplementary conditions, and other Division 01 specification sections, apply to this section.

1.2 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

B. Shop Drawings: For each type and configuration of outdoor, custom air-handling unit.

1. Prepared by manufacturer's factory employees with review and sign-off by those individuals responsible for manufacturing the air-handling units.
2. Include plans, elevations, sections, mounting, and attachment details.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection.
4. Indicate details of construction with materials description including applicable specified standards and material grades in sufficient detail for reviewers to evaluate point by point compliance with requirements indicated for each air-handling unit.
5. Use actual dimensions of internal equipment in preparing Shop Drawings. Identify mechanical equipment shown on Shop Drawings with equipment designations on Drawings.
6. Thickness and finish of all casing materials with cross references indicated where each is used. Uniquely identify and include information for each different casing construction.
7. Details for each unique casing joint and reinforcing. Indicate wall joints, wall to floor joints, wall to roof joints, floor joints, and roof joints.
8. Roofing details.
9. Assembly details of base and casing for units consisting of multiple sections requiring field assembly.
10. Sizes and dimensioned locations of field connections for ductwork, piping, electrical, and controls.
11. Base and casing penetration and sealing details for factory-installed conduit.
12. Base and casing penetration and sealing details for factory-installed piping including coils.
13. Details of casing connections to field-installed ductwork.
14. Size, shape and layout of base members including localized support of internal components.
15. Base materials, thickness, finishes, lifting provisions, and mounting requirements. Uniquely identify and include information for each different base construction. Clearly indicate for each air-handling unit.
16. Recommended points of field attachment with dimensioned locations.
17. Size and location of each access door, including clearing opening size, with door swing indicated.
18. Size and location of each access panel with service equipment superimposed to show relationship of panel to internal equipment.
19. Drain pans and associated piping, with sizes and locations dimensioned, including relationship to internal equipment.
20. Coil framework and support including enlarged details showing framework attachment to air-handling unit base, coil attachment to framework, and means for individual coil removal.
21. Mounting details of all internal components, such as fans, filters, and dampers.
22. Location of receptacles, service lights, and switches.
23. Location of motor controllers and disconnect switches.
24. Size and location of junction boxes used for interface with field electrical power.
25. Point-to-point electrical power wiring diagrams including wire size, conduit size, motor controllers sizes, switch types and ratings, receptacle types and ratings, service light fixture types and ratings.
26. Point-to-point control wiring diagrams including cable types and sizes, conduit sizes, and connected control devices.

27. Point-to-point control tubing diagrams including tubing types and sizes, conduit sizes, and connection controls devices.
28. Control panel drawings drawn to scale showing detailed internal layout.
29. Plans, sections and isometric reviews of hydronic piping systems showing pipe, fittings, flanges, unions, valves, vents, strainers, accessories, specialties and insulation.
30. Indicate code, operating, and maintenance clearances drawn to scale using dashed lines.
31. Indicate weights of internal components, weight of each separately shipped section, and air-handling unit total weight.

C. Delegated Design Submittals: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data.

1. For seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

a. Include design calculations for selecting seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale and coordinated with all building trades.

B. Seismic Qualification Data: Certificates for air-handling units, accessories, and components, from manufacturer.

C. Source quality-control reports.

D. Startup service reports.

E. Field quality-control reports.

F. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.6 FACTORY VISITS FOR PRODUCT INSPECTION

A. While units are being manufactured, and during factory normal working hours, allow escorted access to manufacturing facility for Owner or Owner's designated representative to verify product compliance with requirements indicated.

1. As many as 3 persons shall visit the factory for product inspection.

B. Manufacturer shall provide Owner and Architect with written notice at least 30 business days before units go into assembly.

C. Inspection visits shall be scheduled with manufacturer at least 10 business days before visit.

D. Personnel making visits for product inspection purposes shall comply with manufacturer requirements for visitors.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: one year from date of Substantial Completion.

B. Extended warranties include, but are not limited to, the following:

1. Complete Air-Handling Unit: one year from date of Substantial Completion for entire air-handling unit and longer where indicated for individual components.
2. Parts: Two years from date of Substantial Completion for all components in the unit.
3. Compressors: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handing units and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design air-handling units, vibration isolation, and seismic restraints

including comprehensive engineering analysis, using performance requirements and design criteria indicated.

F. Casing Structural Performance:

1. Floor:

a. Floor assembly shall support a minimum distributed live load of 150 psf and a minimum concentrated load of 300 lb applied over one square foot without permanent deformation.

b. Floor shall provide a stable walking surface for maintenance personnel and shall be designed to prevent oil-canning.

2. Walls and Roof:

a. Capable of withstanding positive and negative 8 in. w.g. internal static pressure without exceeding a midpoint deflection of L/240 of span.

b. Roof shall be designed to support a minimum live load of 75 psf and a minimum concentrated load of 300 lb.

3. Base Frame:

a. Unit base shall be fully welded structural construction.

b. Base frame shall support all shipping, rigging, operating and maintenance loads without permanent deformation.

c. Maximum rigging deflection shall not exceed L/360 of unit length

G. Casing Leakage Performance: Comply with more stringent of the following requirements:

1. Unit casing leakage shall be tested and rated in accordance with AHRI Standard 1350 Maximum casing leakage shall be Class A at ±8 in. w.g.
2. Manufacturer shall provide certified test data demonstrating compliance.

H. Casing Thermal Performance:

1. Unit casing shall comply with AHRI Standard 1350 Thermal Class T2 or better

2. Surface Condensation: Air-handling manufacturer shall evaluate potential for condensation and design and manufacture entire unit casing to prevent condensation at most extreme operating conditions encountered.
3. Thermal Break: AHRI 1350 Thermal Bridging Class TB2 or better. Incorporate a thermal break at each through metal path to prevent condensation from occurring on interior and exterior of casing.
4. Insulation: Shall be fully enclosed and not exposed to the airstream.

I. Air Tunnel Aerodynamic Performance: Position air-handling unit internal components and transition between internal components to maintain uniform airflow; minimize sound levels and energy consumption. Use methods indicated and other means to ensure compliance.

1. Use turning vanes if necessary to direct the air path.

a. Design, manufacture, and install vanes in accordance with applicable requirements in ASHRAE and SMACNA guidelines, handbooks, and standards.
b. Install vanes firmly in place so that no vane movement occurs at worst-case airflow capacity possible.

2. Use fan inlet and discharge transitions and other devices to maximize system regain and minimize airborne sound levels.
3. Center system components such as coils, fans, and filters, vertically and horizontally, in the airstream.
4. Maintain spacing between components such that airflow patterns to adjacent components are as uniform as possible and that component "dead spots" or "jetted areas" are avoided.
5. Design and install internal structural supports, piping, and conduit that do not block airflow and impede performance of coils, fans, filters, and other unit components, and service space clearances.

J. Casing Acoustical Performance:

1. Sound Insertion Loss: Minimum acceptable sound insertion loss (dB) of perforated inside casing assemblies when tested by an independent testing laboratory in accordance with ASTM C423 and ASTM E795:

a. 125 Hz: 16 dB.
b. 250 Hz: 30 dB.
c. 500 Hz: 32 dB.
d. 1000 Hz: 33 dB.
e. 2000 Hz: 34 dB.
f. 4000 Hz: 63 dB.
g. 8000 Hz: 60 dB.

K. Durability Performance: Design and manufacture air-handling units with underlying requirement to provide a highly durable piece of equipment.

1. Unit Life Expectancy: 25 years.
2. Supporting Documentation: Submit documentation showing proposed products to consider and include design features, components, and materials to satisfy requirement.

L. Safety:

1. Comply with OSHA regulations.
2. Exposed sharp edges and corners of metal shall be protected or rounded to prevent injury to personnel not wearing gloves.
3. Cover exposed ends of screws with plastic or metal covers to prevent injury to personnel coming in contact with screws.

M. Serviceability:

1. Hoisting Provisions: Fans and motors weighing more than 100 lb. to have full-length hoist rails mounted over the equipment to facilitate service, removal, and replacement.
2. Mounting Location: Install internal components in readily accessible locations to facilitate ease of service and replacement.

3. Service Access:

    a. Internal components shall be serviceable through access sections with doors indicated on Drawings.
    b. Internal components shall be removable and replaceable through access doors or panels.
    c. Review requirements for access doors and panels indicated and recommend additional access doors and panels if required for uninhabited service, removal, and replacement of components.

4. Tripping Hazards: Floors in accessible sections of air-handling unit shall be free of standing seams, reinforcing, supports, or section splits located in the walking path that is capable of causing a tripping hazard. Locate section splits immediately adjacent to internal walls.

N. Quality: Type and thickness of materials indicated are the minimum acceptable. Provide better-quality materials of a heavier thickness if required to comply with performance requirements indicated.

1. If manufacturer's standard construction exceeds requirements indicated, use manufacturer's standard construction.
2. If manufacturer's standard construction does not comply with requirements indicated, modify manufacturer's standard construction to comply with requirements.

O. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Component Importance Factor: 1.0.

P. Vibration Performance: Air-handling unit manufacturer shall evaluate vibration of internal components installed inside of air-handling units and include internal vibration isolation required to limit the vibration transmitted to the building at a low enough level that vibration is not perceived by building occupants.

2.2 CAPACITIES AND CHARACTERISTICS

A. See equipment schedules on Drawings.

2.3 OUTDOOR, CUSTOM AIR-HANDLING UNITS

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

:
1. Innovent
2. Venmar

3. XeteX

B. Unit Arrangement and Configuration:

1. Arrangement: Project-specific arrangement and configuration of air-handling units indicated on Drawings. Do not deviate from requirements indicated without submitting a formal request clearly describing each deviation and reason for each deviation, and only after receiving Architect's written acceptance.
2. Mounting Requirements: Units mounted on roof curbs.
3. Multiple Sections, Splits: Air-handling unit manufacturer to determine number of sections and location of section splits required for each air-handling unit in accordance with the following criteria:

    a. Physical size and weight of each section, on-site path of travel, and methods for erection and installation. Air-handling manufacturer to review criteria with Installer before preparing Shop Drawings.
    b. Maximize physical size of each air-handling unit section considering shipping, moving, erecting, and installation.
    c. Minimize the number of air-handling unit sections requiring field assembly. Preference is for single-piece air-handling units where possible.

C. Air-Handling Unit Base:

1. Performance:

    a. Air-handling unit manufacturer shall design the structural base to support the casing, internal components, operating loads, shipping loads, rigging loads, and maintenance loads without permanent deformation.
    b. Design air-handling units to be lifted from only the air-handling unit structural base and not the casing.
    c. Support air-handling units from only the perimeter base unless otherwise indicated on Drawings.
    d. Air-handling unit manufacturer to size and locate intermediate structural base supports as required to comply with structural performance indicated for air-handling unit floors.
    e. Level base before factory assembly of air-handling unit casing and internal components to ensure proper fit and alignment.

2. Structural Member Size:

    a. Air-handling unit manufacturer shall select size of base members and construction of base to withstand the rigors of loading, unloading, shipping, and rigging without damage to air-handling unit components or misalignment of factory-assembled components.
    b. Depth and weight of structural members shall be selected by air-handling unit manufacturer to comply with performance requirements indicated.
    c. Depth of perimeter base members is not less than 8 inches deep.

3. Structural Member Spacing: Positioned as required to satisfy structural requirements, but not to exceed 24 inches.

4. Materials: structural carbon steel, ASTM A36/A36M.

    a. Perimeter Members: G channel equivalent structural shape capable of meeting all specified structural, rigging deflection, floor loading, and casing performance requirements.
    b. Intermediate Members (Spanning Full Width of Unit): C channel equivalent structural shape capable of meeting all specified structural, rigging deflection, floor loading, and casing performance requirements. Cross Members (Spanning Intermediate Members): C channel equivalent structural shape capable of meeting all specified structural, rigging deflection, floor loading, and casing performance requirements.

    .

5. Carbon-Steel Finish: Carbon-steel base components shall be protected with a factory-applied corrosion-resistant coating system. Coating performance shall demonstrate a minimum 1,500-hour salt spray resistance when tested in accordance with ASTM B117.Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

    a. Use welding materials with corrosion properties equal to material being welded.

6. Welding Procedures:

    a. Structural Welding Codes: AWS D1.1/D1.1M for carbon steel. AWS D1.2/D1.2M for aluminum construction, as applicable.
    b. Join structural members to one another using continuous or stitchwelds.
    c. After welding and fabrication, deburr and grind exposed welds to provide smooth surfaces free of sharp edges.

7. Penetrations through Base Perimeter: Seal pipe, tubing, and conduit penetrations through base perimeter members to provide a watertight assembly.
8. Section Joints: Air-handling units consisting of multiple sections for field assembly shall be joined with structural joining plates.

    a. Joining plate material type to match base.
    b. Joining plate of thickness required to join sections without resulting in a permanent deflection, minimum 1/2 inch thick.
    c. Continuously weld joining plates to each mating end of base.
    d. Joining plates shall not extend beyond outer edge of adjoining base.
    e. Plates to include at least three equally spaced holes for field connection using factory-furnished threaded hardware of a nominal diameter of at least 1/2 inch.

9. Lifting Provisions: Air-handling unit manufacturer to design and install lifting lugs of size and location required to comply with performance requirements indicated.
10. Curb Cap:

    a. For air-handling units installed on a continuous perimeter curb, provide air-handling unit base with a continuous structural angle counterflashing.
    b. Angle shall extend down vertical face of curb to completely cover wood nailer.

c. Coordinate inside dimension of angle counterflashing with curb dimension and roofing. Provide adequate clearance between angle counterflashing and roofing over curb.

D. Unit Casings:

1. Casing Assembly:

a. Appearance:

1) Exposed exterior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.5 inch beyond the exterior skin surface.
2) Underside of air-handling units with finished installation exposed to view shall have finished appearance matching casing walls. Casing shall be recessed within the perimeter structural base to provide a single contiguous plane.
3) Interior surfaces of casing shall have a neat and finished appearance free of standing seams, exposed reinforcing, and other casing protrusions more than 0.5 inch beyond the skin surface.

b. Dissimilar Metals: Isolate dissimilar metals that are in contact to prevent galvanic action and corrosion.
c. Framing and Supports: Interconnect and support individual casing wall and roof panels using either formed panel construction or framed construction with structural support members. For framed casing construction, materials used to construct casing of structural support members shall be as follows:

1) Casings with Aluminum Outer and Inner Skins: Aluminum extrusions in accordance with ASTM B211 Alloy 6063 T6.
2) Casings with Galvanized-Steel Outer and Inner Skins: Galvanized steel.
3) Casings with Galvanized-Steel Outer Skin and Aluminum or Stainless Steel Inner Skins: Stainless steel.

d. Seals: Seal interior and exterior joints and seams to make casing air- and water-tight. Trim factory-applied sealant flush with adjacent surface.
e. Double-Wall Casings: Consisting of insulation sandwiched between an outer and inner metal wall. Use double-wall casings to construct air-handling units unless septum casings are required.
f. Septum Casings: Triple-wall construction consisting of a solid metal inner wall sandwiched between insulation layers that are covered with metal walls. Use septum casings for applications having performance requirements that are not achievable with double-wall casings.
g. Penetrations: Seal voids around conduit, piping and tubing penetrations.
h. Floors: Route conduit, pipe, and tube within a floor-mounted pipe sleeve.

1) Sleeve:

a) Fabricate sleeve of aluminum, galvanized-steel, or stainless steel pipe.

b) Extend top of sleeve above adjacent floor surface to prevent standing water on floor from entering annular space of sleeve.
c) Seal sleeve to top of floor for an air- and watertight seal.
d) Seal annular void of sleeve using an adjustable compression seal or nonhardening packing material.

i. Floor Openings with Metal Grating:

1) Factory install walk-on safety gratings over any floor opening large enough to create a safety hazard for operators including, but not be limited to, supply-, return-, and exhaust-air openings.
2) Bar Grating:

a) Materials: Use hot-dip galvanized-steel grating for galvanized-steel floors.
b) Air-handling unit manufacturer shall select depth and thickness of grating bars to limit deflection to 1/360 of span when subjected to a dynamic load of not less than 500 lb.
c) Grating shall be designed to support specified loads while limiting deflection to 1/360 of span. Source: Product manufacturer specializing in metal gratings.
d) Grating bearing surface shall extend beyond clear opening in floor at least 1 inch.

3) Mounting Frame:

a) Mount grating in a continuous structural angle or bar frame so no ends of grating bars are exposed. Top of frame to be flush with top of grating.
b) Secure grating to frame with threaded hardware so grating does not move when walked on but can be easily removed from top to gain access behind grating.
c) Continuously weld mounting frame to air-handling unit floor.

j. Waterproof Floors: Continuously weld floor joints, seams, and penetrations to completely seal floor. Roll all edges of floor up at least 1 inch to create a shallow tub capable of holding standing water.
k. Duct Connections - Direct to Casing: Frame and reinforce unit casing around perimeter of unit duct openings to accommodate direct attachment of field-installed ductwork. Coordinate requirements with Installer to accommodate field connection.

2. Materials for Outer Skin of Casing Walls and Roofs:

a. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 coating; minimum (nominal) 18 gauge thick. Manufacturer's standard aluminum or stainless steel construction may be provided in lieu of galvanized steel, provided equal or greater strength, durability, corrosion resistance, and casing performance requirements are maintained.
b. Application: See Drawings for application of different materials indicated.

3. Materials for Inner Skin of Casing Walls and Roofs:

    a. Galvanized-Steel Solid and Perforated Sheet: ASTM A653/A653M; G90 coating, minimum (nominal) 20 gauge thick. Manufacturer's standard aluminum or stainless steel construction may be provided in lieu of galvanized steel, provided equal or greater strength, durability, corrosion resistance, and casing performance requirements are maintained.
    b. Application: See Drawings for application of different materials indicated.

4. Materials for Floor Walking Surface:

    a. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 coating; minimum (nominal) 18 gauge thick. or manufacturer's standard aluminum or stainless steel construction meeting all specified floor loading and structural performance requirements.

5. Materials for Underside of Floor Insulation:

    a. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 coating, minimum (nominal) 22 gauge thick.
    b. Application: See Drawings for application of different materials indicated.

6. Materials for Internal Walls:

    a. Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 coating; minimum (nominal) 18 gauge thick.

7. Surfaces in Contact with Airstream:

    a. Comply with ASHRAE 62.1 and NFPA 90A.
    b. Glass or mineral-fiber insulation installed behind perforated metal shall be encapsulated to prevent insulation fibers from entering the airstream by using a polymer sheet material or tightly woven glass cloth material that does not impact the acoustical absorption properties of insulation.

8. Insulation for Casing Walls and Roofs Not Exposed to Airstream:

    a. Materials Not Exposed to Airstream: injected polyurethane foam insulation with a minimum nominal density of 2 lb/cu. ft.
    b. R-Value: Minimum R-12.
    c. Thickness: Minimum 2 inches.
    d. Insulation shall completely fill the casing cavity so no voids exist.

9. Insulation for Casing Walls and Roofs Exposed to Airstream:

    a. Materials Exposed to Airstream: Injected polyurethane foam insulation with a minimum density of 2 lb/cu. ft.
    b. R-Value: Minimum R-12.
    c. Thickness: Minimum 2 inches.
    d. Insulation shall completely fill the casing cavity so no voids exist.

10. Insulation for Casing Floors:

    a. Materials: injected polyurethane foam insulation with a minimum nominal density of 2 lb/cu. ft..
    b. R-Value: Minimum R-12.
    c. Thickness: Minimum 2 inches.
    d. Insulation shall completely fill the casing cavity so no voids exist.

11. Access Doors:

    a. Application: Install access doors downstream and upstream of all internal components.
    b. Adjustment: Design doors for field adjustment capable of maintaining specified leakage rate.
    c. Mounting Height: Install bottom of door frame within 2 inches of air-handling unit floor walking surface.
    d. Performance: Leakage as required to satisfy overall unit leakage performance indicated, but not more than 1.0 cfm per door when tested at 10 inches wg.
    e. Fabrication: Formed and reinforced, constructed of same materials and thicknesses as casing. Where doors are installed in casing walls with perforated interior, install doors with solid interior.
    f. Swing: Arrange doors to be opened against pressure, unless otherwise indicated on Drawings.
    g. Frame: Extruded aluminum with thermal break with welded mitered corners.
    h. Handles:

        1) Secure door closed using not less than two roller-style latches with handles located at quarter points along door height.
        2) If three latches with handles are included, install one at midpoint of door height and equally space others.
        3) Air-handling unit manufacturer has option to use a multipoint latching mechanism that is operable from a single door handle located at midpoint of door height, but secures door to frame at top, bottom, and handle location.
        4) Include door handles on outside and inside of door to allow operator access to open and close door from outside and inside of unit.
        5) Field adjustable to accommodate changes to fit and gasket compression.
        6) Durable product capable of withstanding repeated opening and closing of door while operating under design pressure without damage.

    i. Hinges: full-length, concealed, stainless steel piano hinge.
    j. Gasket:

        1) Design: Specially formed with an internal air chamber specifically designed to seal on two surfaces without taking a permanent set.
        2) Dual Gaskets: Primary and secondary gasket.
        3) Location: Install gaskets around entire perimeter of doors or frames.
        4) Material: EPDM, neoprene, or santoprene.
        5) Protection: Seat gasket in a protective metal ribbed chamber integral to door or door frame to protect gasket from damage by operator incidental contact.
        6) Service: Field replaceable.

7) Adhesive-backed tape-type gaskets adhered to a single flat surface are unacceptable.

k. Size of Door Frame Clear Opening: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.

1) Width: At least 24 inches clear inside of door frame.
2) Height: Full clear height of unit casing up to a maximum height of 72 inches clear inside of door frame.

l. Safety Latches and Stops:

1) Safety Latches: Install safety latch with retainers on outward swing doors that do not open against pressure to allow restricted travel for purpose of pressure relief and so that doors do not open uncontrollably due to inside pressure.
2) Stops: Install cushioned door stops on inward swinging doors where necessary to limit door travel that could potentially damage the door or internal components.

m. Tie-Backs: Install tie-backs with retainers on outward-swinging access doors to hold doors in an open position during service.

n. Windows:

1) Construction: Fabricate windows with frame mounted in access doors of double-glazed safety glass with an airspace between panes and interior and exterior seals.
2) Condensation Control: Install desiccant material in airspace between panes if necessary to prevent condensation from forming on glazing.
3) Clear Viewing Size: Minimum 12 inches, square or round.
4) Mounting Location: Center window in the door width. For doors up to 72 inches high, locate top of window 18 inches below top of door.
5) Application: Install windows in all access doors.

o. Nameplates:

1) On each access door, include a nameplate defining the access to service within. Nameplates shall be included for, but not be limited to, the following:

a) Dampers.
b) Filters.
c) Cooling Coils.
d) Heating Coils.
e) Supply Fans.
f) Return Fans.
g) Air-handling unit designation.
h) Where door access is to multiple components, list all components accessed. For example: Filter/Cooling Coil.

i) For each door that does not open against static pressure, include a warning sign stating: "DANGER: DOOR UNDER PRESSURE. DO NOT OPEN WITH FAN ON."

2) Lettering Size and Style: At least 1-inch- high, block style.
3) Material: Lettering engraved in black plastic on a white plastic back. Engraving shall penetrate through black plastic so lettering reads white.
4) Attachment: Attach nameplates to door using high-strength bonding cement and stainless steel screws.
5) Mounting Location:
   a) For access doors with windows, locate nameplate directly above window frame and center in door width.
   b) Align nameplates of all doors for uniform placement.

12. Access Panels:

a. Performance: Leakage as required to satisfy overall unit leakage performance indicated.
b. Fabrication: Formed and reinforced panels of same material and thickness as casing.
c. Fasteners: Adjustable, reusable type for multiple operations without degradation due to reuse. Do not use screws capable of stripping.
d. Arrangement: Panels removable from exterior side of casing.
e. Gasket: EPDM, neoprene, or santoprene similar to access doors, applied around entire perimeter of panels or frames.
f. Location and Size:

1) Coils: Oversized access panel to allow removal and replacement without impacting adjacent casing.
2) Fans: Oversized access panel to allow removal and replacement of entire fan assembly including base without impacting adjacent casing.

13. Standing-Seam Metal Roof: Construct air-handling unit roof casing with standing seams designed for waterproof roofing applications.

a. Construct air-handling unit roof using same materials and finish as walls.
b. Slope roof away from primary access side of unit at not less than 1 percent.
c. For air-handling units shipped in multiple sections, include standing-seam joiners at each split with adhesive, hardware, and cover strips for field joining by Installer.

14. Piping Enclosures:

a. Description: Integral accessible enclosure(s) to house field-installed piping from below and connecting to hydronic coils.
b. Size: Adequate clearance for field installation of piping, valves, accessories, and associated insulation.

1) Maintain at least 6 inches of clearance between inside of enclosure and face of pipe insulation at most restricted point.

c. Construction:

1) Base, Walls, and Roof: Match air-handling unit.
2) Floor: Not required, open to below.
3) Access Doors:

a) Size for full front access to piping, valves, and accessories installed within enclosure.
b) Double-door applications with removable center mullions for unrestricted access.

d. Electrical: Factory install and wire service light with switch and receptacle for each enclosure.

E. Wall Louvers:

1. Wall Louvers, Drainable Blade:
a. Performance:
1) Air Pressure Drop, Rating: Less than 0.1 inch wg at free area intake face velocity of 700 fpm.
2) Face Velocity: If louver size is not indicated on Drawings, size louver for 700-fpm velocity across louver free area.
3) Free Area: 54 percent or more for a 48-by-48-inch representative sample.
4) AMCA 500-L: Beginning point of water penetration at 870 fpm.

b. Features:

1) Depth: 4 inches.
2) Frame: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy.
3) Blades: 0.080 inch thick, ASTM B211, Grade 6063, T5 temper, extruded-aluminum alloy; stationary in horizontal position, drainable.
4) Stationary vertically positioned blades.
5) Bird Screen: 0.5-by-0.040-inch expanded flattened aluminum attached to back of louver.
6) Finish: Match exterior casing.

c. Air-Handling Unit Factory Assembly:

1) Install louver face flush with exterior of casing and seal to provide a weathertight installation.
2) Secure louver in casing and include additional bracing if required to handle loading of extreme outdoor environmental performance indicated.

d. Application: Factory install louvers in air-handling casing.

F. Internal Structural Supports:

1. General:

a. Air-handling unit manufacturer shall design and assemble air-handing unit internal structural supports for attachment and support by air-handling unit structural base.
b. Factory install structural supports for internal support casing if required to comply with casing structural performance.
c. Factory install hoist beams and rails over equipment to comply with performance requirements for service.

2. Structural Member Size and Spacing:

a. Size: Air-handling unit manufacturer shall select size of members and construction to do the following:

1) Withstand the rigors of loading, unloading, shipping and rigging without damage to air-handling unit components or misalignment of factory-assembled casing and components.
2) Comply with performance requirements indicated.

b. Spacing: Positioned as required to comply with requirements.

3. Materials: Structural aluminum, ASTM B209, Alloy 6061 T6.

a. Structural Supports: Angle, channel, I or W beam shapes, or tube shapes selected by air-handling unit manufacturer for application.
b. Hoist Beams for Internal Components (Spanning Full Width of Unit): I or W beam shapes.

G. Centrifugal Fan Arrays:
1. Sourcing Option: In lieu of sourcing fan array assemblies from a specialty fan manufacturer, air-handling unit manufacturer has option to furnish in-house fan array assemblies that achieve equal or better performance while complying with other requirements indicated.
2. Operating Performance:

a. Air-handling unit manufacturer shall account for, and include in, submitted fan selections any static pressure drops associated with unit, and system effect due to fan operating in the air-handling unit.

1) Add additional static pressure to fan scheduled total static pressure.
2) If fan motor horsepower is increased, notify Engineer.

b. Fans shall have sharply rising pressure characteristics at operating point and stable in operation. Fan horsepower characteristics shall be self-limiting and non-loading.
c. Fan speed, brake horsepower, and sound power levels indicated are maximum acceptable.
d. Scheduled motor horsepower, airflow rate, and static pressure are minimum acceptable. Motor horsepower shall be capable of handling maximum horsepower of fan at scheduled speed.
e. At a minimum, fans shall have AMCA class indicated on Drawings.

1) Fan operating limits shall be in accordance with AMCA 99 for AMCA class indicated.
2) If AMCA class is not indicated, use AMCA 99 as basis for determining AMCA class.
3) AMCA class selected shall be capable of accommodating a plus 10 percent increase to fan static pressure indicated on Drawings.

f. Motor starting torque shall exceed fan speed-torque requirements.
g. Airflow Profile:

1) Fan arrangement within fan array shall produce a uniform airflow and velocity profile across air-handling unit air tunnel when measured 12 inches upstream of fan inlet and 48 inches downstream of fan inlet.

3. Vibration Balance:

a. Each fan/motor assembly shall be factory balanced to AMCA 204, BV-3, Balance Quality Grade G6.3 or better through entire operating speed range from minimum speed to maximum speed. If minimum speed is not indicated on Drawings, assume minimum speed to be 20 percent of design speed.
b. Identify and record each speed and speed range within the fan operating range that could cause potential vibration problems.
c. Submit test reports as an informational submittal for Project record.

4. Vibration Isolation: Install vibration isolation on each fan/motor assembly in the fan array, except vibration isolation may be omitted on fans/motor assemblies balanced to AMCA 204, BV-5, with a maximum residual imbalance of 0.22-in./s peak, filter in.
5. Operation and Service Requirements:

a. Fan array shall be divided into two independently operable groups of fans. Each fan group shall be served by a dedicated variable-frequency drive

b. Remaining fans in array shall continue to operate in maintaining the ductwork static pressure setpoint. with one or multiple failed fans.
c.
d. A single fan, motor, drive, or control failure shall not reduce available fan array capacity below 75 percent of scheduled airflow. Fan wheel/motor assembly shall pass through the air-handling unit access door servicing fans. Entire individual fan assembly shall pass through the door to the room where air-handling unit is located.
e. Design and incorporate features to permit safe, rapid, and economical maintenance.

6. Fan Base, Stackable Fan Units:

a. Mount fan/motor on aluminum, galvanized-steel or powder-coated steel base.
b. Include base and vibration isolators in accordance with requirements indicated.
c. Weld structural members to form a rigid base.
d. Size and design the base construction to withstand the rigors of shipping and rigging.

e. Include the base with lifting lugs or holes.

7. Fan Frame:

   a. Construct frame of aluminum, galvanized steel or powder-coated steel.
   b. Reinforce and brace frame to prevent excessive deflection and pulsation.
   c. Include stiffeners to form a rigid frame that is free of structural resonance and vibration.

8. Fan Panel:

   a. Construct fan panel of galvanized steel.
   b. Reinforce and brace fan panel to prevent excessive deflection and pulsation.
   c. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.

9. Fan Inlet Cone:

   a. Include a precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of fan blades.
   b. Inlet cone shall be a smooth hyperbolic shape.
   c. Inlet cone shall be a single piece, constructed of aluminum or powder-coated steel.
   d. Fasten inlet cone to fan panel using bolts, nuts, and washers to provide a positive and secure attachment that can be field removable.

10. Fan Wheel:

   a. Fan blades shall be a true hollow airfoil shape, welded to backplate and wheel cone.
   b. Construct blades of aluminum, reinforced for AMCA fan class.
   c. Design blades to provide smooth airflow over all surfaces of blade.
   d. Construct fan hubs of aluminum with integral bracing for extra strength and stiffness.

      1) Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects.
      2) Clean surfaces of castings by blasting, pickling, or any other standard method.
      3) Mold-parting fins and remains of gates and risers shall be chipped, filed, and ground flush.
      4) Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance.

   e. Hubs shall be keyed and set-screwed to motor shaft for positive attachment.
   f. Construct wheel backplates of aluminum.
   g. Select entire rotating assembly so first critical speed is at least 30 percent greater than fan design speed and at least 20 percent greater than maximum speed in AMCA fan class.

11. Fan Drive:

a. Direct drive, arrangement 4 in accordance with AMCA 99.
b. Adjust wheel width and diameter to match motor speed while providing performance scheduled.
c. Fasten fan wheel directly to motor shaft using a key in motor shaft and setscrew.
d. Construct motor base and pedestal supports of galvanized steel.
e. Fan Speed Limitation:

    1) Fan speed at design conditions indicated shall not exceed speed on motor nameplate.
    2) Do not select fans to operate at motor speeds greater than motor nameplate.

12. Fan Motors: See "Fan Motors" Article for ac motors.

13. Fan Sound Silencing Enclosure:

    a. Include each fan of the fan array with integral sound silencer enclosure to reduce the bare fan discharge sound levels by at least 8 dB through octave band frequencies from 125 to 8000 Hz.
    b. Enclosure shall not increase the fan array length beyond size indicated on Drawings.
    c. Silencing enclosure shall not add static pressure loss.
    d. Double-wall construction consisting of sound absorbing insulation sandwiched between a solid metal outer skin and perforated metal inner skin.

        1) Outer Skin Material: Aluminum or Galvanized steel.
        2) Inner Skin: Material Aluminum or Galvanized steel.
        3) Insulation Material: fiber free.

    e. Enclosure shall provide a physical separation between operating adjacent fans to prevent a negative performance.

14. Backdraft Damper:

    a. Include each fan in the fan array with a backdraft damper at the fan inlet to prevent air circulation through a fan that is not operating.
    b. Open backdraft damper when fan is operating and close when fan is not operating.
    c. Design backdraft damper assembly to operate with little to no static pressure loss with fan operating throughout entire operating range from design to minimum airflow.

        1) Add damper pressure loss to fan scheduled total static pressure.
        2) If pressure loss requires a change field electrical power, air-handling unit manufacturer shall be responsible for associated cost of change.

    d. Fasten backdraft damper assembly to fan panel or enclosure using hardware designed for easy removal by maintenance personnel.
    e. Dampers shall not create measurable additional noise above the sound level of fan.
    f. Dampers shall not vibrate or rattle.
    g. Construct dampers of extruded aluminum, stainless steel, or powder-coated steel.

15. Hardware: Hex-head, high-strength carbon steel with corrosion-resistant coating or 300 series stainless steel.
16. Nameplates:

    a. Construct nameplates and rotation arrows of aluminum or 300 series stainless steel.
    b. Securely fasten nameplate and rotation arrow to fan housing using pins or sheet metal screws.
    c. Locate nameplates in a highly visible location on motor side of fan.
    d. Engrave, stamp or label the following information on nameplate:

        1) Manufacturer, address, phone number, and website address.
        2) Manufacturer model number.
        3) Serial number.
        4) Manufacturing date.
        5) Fan size.
        6) Fan schedule equipment designation (may be listed on a separate nameplate if there is insufficient space).
        7) Design airflow.
        8) Design static pressure.
        9) Design fan speed.
        10) AMCA fan class.

17. Air-Handling Unit Factory Assembly:

    a. Internal Access: Include each fan with internal access from downstream and upstream sides as indicated on Drawings.
    b. Removal and Replacement: Each fan wheel and motor shall be independently removable and replaceable through a removable access door installed in air-handling unit casing.
    c. Stackable Fan Arrays: Construct framework from aluminum, galvanized steel, painted steel, or stainless steel.
    d. Panel-Mounted Fan Array Supports:

        1) Construct a freestanding and self-supporting structural framework to support each fan individually from and independent of adjacent fans.
        2) Construct framework from aluminum, galvanized steel, painted steel, or stainless steel.

H. Centrifugal Plenum Fans:
1. Operating Performance:

    a. Air-handling unit manufacturer shall account for, and include in, submitted fan selections any static pressure drops associated with unit, and system effect due to fan operating in the air-handling unit.

        1) Add additional static pressure to fan scheduled total static pressure.
        2) If fan motor horsepower is increased, notify Architect.

    b. Fans shall have sharply rising pressure characteristics at operating point and stable in operation. Fan horsepower characteristics shall be self-limiting and non-loading.

c. Fan speed, brake horsepower, and sound power levels indicated are maximum acceptable.
d. Motor horsepower, airflow rate, and static pressure are minimum acceptable. Motor horsepower shall be capable of handling maximum horsepower of fan at scheduled speed.
e. Fan air performance ratings shall be based on tests in accordance with ASHRAE 51/AMCA 51 and AMCA 210.
f. Base fans sound ratings on AMCA 300 and calculation methods in accordance with AMCA 301.
g. At a minimum, fans shall have AMCA class indicated on Drawings.

1) Fan operating limits shall be in accordance with AMCA 99 for AMCA class indicated.
2) If AMCA class is not indicated, use AMCA 99 as basis for determining AMCA class.
3) AMCA class selected shall be capable of accommodating a plus 10 percent increase to fan static pressure indicated on Drawings.

h. Motor starting torque shall exceed fans speed-torque requirements.

2. Vibration Balance:

a. Each fan/motor assembly shall be factory balanced to AMCA 204, BV-3, Balance Quality Grade G6.3 or better through entire operating speed range from minimum speed to maximum speed. If minimum speed is not indicated on Drawings, assume minimum speed to be 20 percent of design speed.
b. Identify and record each speed and speed range within the fan operating range that could cause potential vibration problems.
c. Submit test reports as an information submittal for Project record.

3. Operation and Service Requirements:

a. Each fan/motor assembly shall be capable of lock-out/tag-out procedure without interrupting operation of other fans in air-handling unit.
b. Design and incorporate features to permit safe, rapid, and economical maintenance.

4. Fan Base:

a. Mount fan, motor, and drive on a structural-steel or an aluminum base; except, where indicated on Drawings, install fan on a concrete-filled inertia base.
b. Include base and vibration isolators in accordance with requirements indicated.
c. Electrically weld the base.
d. Size and design the base construction to withstand the rigors of shipping and rigging.
e. Include the base with lifting lugs or holes.
f. Construct base with gusseted brackets to accommodate spring isolators indicated.

5. Fan Panel:

a. Construct fan panel of aluminum or powder-coated steel.
b. Support fan wheel and bearings from structural aluminum or powder-coated steel framework.
c. Reinforce and brace fan panel to prevent vibration and pulsation.
d. Include stiffeners to form a rigid panel that is free of structural resonance and vibration.

6. Fan Inlet and Wheel Cone:

a. Precision-spun or die-formed, matched inlet and wheel cone to ensure streamlined airflow into the wheel and full loading of blades.
b. Inlet and wheel cones shall be hyperbolic.
c. Inlet cone shall be a single piece, constructed of aluminum or powder-coated carbon steel.
d. Fasten inlet cone to fan panel using bolts, nuts and washers to provide a positive and secure attachment that can be field removable.
e. Inlet cones that are held in place using retaining clips are unacceptable.

7. Fan Wheel:

a. Fan blades shall be a true hollow airfoil shape, continuously welded to backplate and wheel cone.
b. Construct blades of aluminum, reinforced for AMCA fan class and operating conditions scheduled.
c. Design blades to provide smooth and aerodynamic airflow over all surfaces of blade.
d. Construct fan hubs of cast aluminum or cast-iron ASTM A48/A48M Class 20A and better, with integral bracing for extra strength and stiffness.

1) Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters, or other similar injurious defects.
2) Clean surfaces of castings by blasting, pickling, or other standard method.
3) Mold-parting fins and remains of gates and risers shall be chipped, filed, and ground flush.
4) Design hubs to maintain a high resistance to fatigue and low relative wheel imbalance.

e. Hubs shall be keyed and set-screwed to shaft for positive attachment.
f. Construct the wheel backplates of aluminum.
g. Statically and dynamically balance fan wheel before fan is assembled.
h. Select entire rotating assembly so first critical speed is at least 30 percent greater than fan design speed and at least 20 percent greater than maximum AMCA class speed.

8. Fan Drive:

a. Direct drive, arrangement 4 in accordance with AMCA 99 for single-width, single-inlet fans.
b. Adjust wheel width and diameter to match motor speed while providing performance scheduled.

c. Fasten fan wheel directly to motor shaft using a key and setscrew as previously specified.
d. Construct motor base and pedestal of aluminum or powder-coated carbon-steel plate.
e. Fan Speed Limitation: Fan speed at design conditions indicated shall not exceed speed on motor nameplate for direct-drive applications. Do not select fans to operate at motor speeds greater than motor nameplate.

9. Protective Screens: Factory furnish and install protective screens on fan inlet and discharge.

a. Expanded metal or welded wire welded to a painted carbon-steel or stainless steel frame.
b. Screens shall comply with OSHA requirements.
c. Screens shall be constructed of painted carbon or stainless steel.
d. Fasten screens to fan frame for easy removal by maintenance personnel.

10. Welding:

a. Use AWS- or ASME-certified welders to weld materials required by application.

11. Hardware: Hex-head, high-strength carbon steel or 300 series stainless steel.
12. Nameplates:

a. Construct nameplates and rotation arrows of aluminum or 300 series stainless steel.
b. Securely fasten nameplate and rotation arrow to fan housing using pins or sheet metal screws.
c. Locate nameplates in a highly visible location on motor side of fan.
d. Engrave, stamp or label the following information on nameplate:

1) Manufacturer, address, phone number, and website address.
2) Manufacturer model number.
3) Serial number.
4) Manufacturing date.
5) Fan size.
6) Fan schedule equipment designation (may be listed on a separate nameplate if there is insufficient space).
7) Design airflow.
8) Design static pressure.
9) Design fan speed.
10) AMCA fan class.

e. Air-Handling Unit Factory Assembly:
f. Internal Access: Include each fan with internal access from downstream and upstream sides as indicated on Drawings.
g. Removal and Replacement: Each fan shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.
h. Fan Supports:

1) Construct a freestanding and self-supporting structural framework to support each fan individually from and independent of adjacent fans.
2) Construct framework from aluminum, galvanized steel, , painted steel, or stainless steel.

I. Fan Motors:
1. Standard: Comply with NEMA MG 1 unless more stringent requirements are indicated.
2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium-induction motor.

a. Performance:

1) Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
2) Efficiency: NEMA Premium Efficiency rating complying with NEMA MG 1.
3) Motor Horsepower: Minimum size as indicated on Drawings. Motor shall operate fan under all conditions indicated without exceeding motor nameplate and without use of motor service factor.
4) Inverter-Duty Rating: Comply with minimum requirements of Class F or Class H insulation, suitable for "inverter-duty" or "drive-duty" applications in accordance with NEMA MG 1. Motor operation through a variable-frequency controller shall not adversely affect the motor performance, operation, useful life, and warranty.
5) Service Factor: 1.15.
6) Temperature Rise: Match insulation rating.

3. Enclosure Type: TEFC.
4. Shaft Grounding System:

a. Shaft grounding system to protect bearings from induced voltage.
b. Shaft grounding system shall have low drag (less than 0.05 percent of motor horsepower) and shall operate for a minimum of three years without periodic maintenance or adjustments.
c. Mounting: External or internal to motor enclosure.

5. Frame:

a. Frames with integrally cast feet unless other requirements of driven equipment require a different arrangement.
b. Frame, front and back end brackets, and front and back end bearing intercaps constructed of cast iron, ASTM A48/A48M, Class 25 or better.

6. Rotor:

a. Fabricate rotor frame from die-cast aluminum, copper, or associated alloys.
b. Key rotors to motor shaft.

c. Rotating assembly shall be dynamically balanced to within limits defined in NEMA MG 1.
d. Motors shall have the entire rotating assembly between bearing inner caps coated with a corrosion-resistant coating.

7. Stator:

a. Copper windings shall be spike resistant to withstand 1600 peak V.
b. Entire wound and insulated stator coated with a coating to protect against moisture and corrosion.

8. Shaft:

a. Solid shaft fabricated of Type 304 stainless steel, accurately turned, ground and polished, and inspected for accuracy.
b. End of shaft with drilled hole for use in field measurements.

9. Bearings:

a. Grease-lubricated ball or roller bearings.
b. ABMA 11 L-10 motor bearing life of 100,000 hours.
c. Bearing Lubrication:

1) Factory lubricate motor bearings using a premium moisture-resistant polyurea thickened grease with rust inhibitors suitable for extreme operating temperatures encountered.
2) Coordinate special requirements that may impact lubrication and include appropriate lubrication.

d. Grease Fittings:

1) Equip each bearing housing with an easily accessible grease inlet.
2) Provide remote-mounted grease fittings on a centralized manifold with protective caps. The manifold shall be readily accessible and arranged to permit lubrication of all bearings while the unit remains in operation. Equip inlets with an automatic grease relief fitting to prevent excessive greasing.
3) Equip each bearing housing with grease drain and threaded plug.

10. Conduit Box:

a. Material same as frame.
b. For motor frames 365T and below, furnish conduit boxes sized with internal volumes in accordance with NEMA MG 1.
c. For motor frames larger than 365T, furnish conduit boxes one size larger than NEMA MG 1.
d. Coordinate the location and mounting of conduit box with driven equipment manufacturer.
e. Factory mount conduit box on motor.

11. Grounding: NRTL-listed clamp-type grounding lug mounted in conduit box.

12. Motor Leads:

    a. Non-wicking type, Class F temperature rating or better and permanently numbered over entire length for identification.
    b. Lead terminals shall be manufacturer's standard.

13. Condensate Drains:

    a. Motor with drain holes at the lowest point for drainage of condensate.
    b. Each drain hole with a threaded removable plug.

14. TEFC Motor Fans: Corrosion-resistant construction, non-sparking, metallic or non-metallic, bi-directional, and keyed to shaft.

    a. Motor Fan Cover: Steel.

15. Hardware: Hex-head, high-strength, zinc-plated carbon steel or stainless steel.
16. Lifting Eyebolts: Eyebolt threaded into frame receptacle and design to prevent moisture and other foreign material from entering motor cavity when eyebolt is removed.
17. Nameplates:

    a. Construct nameplates of aluminum or stainless steel and attach to motor frame with aluminum, stainless steel, or brass drive pins.
    b. Engrave or stamp data on the nameplate.
    c. At a minimum, include nameplate data in accordance with NEMA MG 1.

18. Paint: Successfully pass 1000-hour salt spray test for corrosion in accordance with ASTM B117.

J. Vibration Isolation:

1. General:

    a. Provide fans inside air-handling units with base and vibration isolation indicated on Drawings.

2. Inertia Bases:

    a. Description: Reinforced structural base designed for concrete infill with integral bolting provisions for fan mounting.
    b. Design and Performance:

        1) Weight of inertia base including concrete infill a minimum of 1.5 times the operating weight of fan.
        2) Base thickness not less than 1/12 of longest span.
        3) Minimum base thickness is as follows:

            a) Up to 15 HP: 6 inches.
            b) 20 to 50 HP: 8 inches.
            c) 60 to 75 HP: 10 inches.

d) 100 HP and Larger: 12 inches.

c. Construction:

1) Base Materials: Structural carbon steel, ASTM A36/A36M, structural stainless steel, ASTM A276/A276M, Type 304L or structural stainless steel, ASTM A276/A276M, Type 316L.

a) Carbon-Steel Finish, Mill Galvanized: Mill-galvanized carbon-steel bases with weld-damaged areas cleaned, prepared, and painted with galvanized paint after fabrication.
b) Carbon-Steel Base Finish: Carbon-steel bases cleaned in accordance with SSPC SP-1 and painted or hot-dip galvanized after fabrication.

2) Base Structural Members:

a) Perimeter Members: Channel, I or W beam shapes or tube.
b) Intermediate Members (Spanning Full-Width Base): Channel or I or W beam shapes or tube.
c) Cross Members (Spanning Intermediate Members): Angle, channel or tube.

3) Reinforcing Bars: Carbon steel, ASTM A615/A615M, sized for a maximum stress of 20,000 psi when subjected to both static and dynamic loads, and welded in place.
4) Floor: Design inertia base with solid floor in bottom for concrete placement after base installation. Seal to prevent leakage or seepage.

a) Galvanized-Steel Solid Sheet: ASTM A653/A653M; G90 coating, minimum (nominal) 18 gauge thick.

5) Isolator Brackets: Gusseted, height-saving brackets.
6) Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

d. Air-Handling Unit Factory Assembly: Install fans with inertia bases where indicated on Drawings.

1) Coordinate placement of inertia bases with design of air-handling unit structural base. Make provisions for attachment and support.
2) Coordinate inertia base mounting provisions with spring isolators.

3. Spring Isolators:

a. Performance:

1) Deflection: Minimum deflection indicated on Drawings. Use a greater deflection if required to maintain an isolator efficiency of at least 98 percent

under all operating conditions encountered. Calculate isolator efficiency using actual support conditions considering the rigidity of structure.

2) Laterally stable freestanding open-spring mounting.
3) Spring diameter not less than 0.8 of compressed spring height at rated load and in the installed and operating condition.
4) Reserve travel to solid shall be equal to a minimum of 50 percent of rated deflection and in no case less than 25 percent of rated deflection in an installed and operating condition.
5) Ratio of horizontal stiffness to vertical stiffness equal to approximately one.
6) Design and install so that ends of springs remain parallel.
7) Select springs that are non-resonant with equipment related frequencies and natural frequencies of support structure.
8) Springs shall not take a permanent set when compressed to coil bind.
9) Seismic restraints to limit motion under seismic forces to 1/4 inch.

b. Construction:

1) Coat springs with PVC or neoprene. Color-code springs to allow positive identification after installation.
2) Construct baseplates, spring retainers, and other components of galvanized carbon steel or stainless steel. Etch and paint aluminum components.
3) Use nuts, bolts, and washers and other associated hardware constructed of zinc-electroplated carbon steel or stainless steel.
4) Isolators with integral leveling bolts.
5) Baseplates with holes and isolation grommets for bolting.
6) Bond nominal 1/4-inch- thick, neoprene friction pad to baseplate.

4. Thrust Restraints:

a. In sets of two or more, thrust restraints shall consist of springs in series with neoprene isolators.
b. Coordinate and select deflection of thrust restrains with equipment being restrained.
c. Thrust restraints complete with rods and adjustment nuts, plus angle brackets and backing plates for attachment to substrate and equipment being restrained.

5. Elastomeric Grommets:

a. Elastomeric grommets shall be a combination of neoprene washer and bushing.
b. Elastomer shall be 56-durometer maximum.
c. Grommets formed to prevent bolts from directly contacting the secured item.

6. Flexible Connections:

a. Construct flexible connection galvanized-steel or stainless steel edges firmly attached to waterproof and fire-retardant fabric.
b. Fabric shall be 6 inches wide or more.
c. Suitable for operation in extreme temperatures encountered.
d. NRTL listed for application and complying with NFPA 90A.

7. Air-Handling Unit Factory Assembly:

    a. Use precompression -type height-saving brackets with isolators having 2-1/2 inch deflection or greater, to limit exposed bolt length.
    b. Install spring isolators plumb and adjust isolators that are not plumb under operating conditions to make plumb.
    c. Adjust isolators to prevent stress transfer to equipment.
    d. Verify that installed isolators and mounting systems permit equipment motion in all directions.
    e. Restraint fans with isolated thrust resistors to limit displacement to 1/4 inch. Design for the maximum lateral thrust the fan can develop.
    f. Adjust or include additional resilient restraints to flexibly limit fan lateral motion to 1/4 inch during startup and operation of equipment.
    g. Anchor restraints to fixed supports having a stiffness greater than the thrust encountered.
    h. Include at least 2-inch operating clearance between fan bases and walking surface of air-handling unit floor. Before startup, clean out foreign matter between bases and equipment to prevent short circuit.
    i. Flexible Connections:

        1) Install flexible connections at connections to fans.
        2) Install flexible connections in accordance with SMACNA standards and manufacturer's written instructions.
        3) Make fabric joints on the flat run, not the corners, with overlap to provide an area sufficient to make a positive seal.
        4) Apply adhesive between fabric layers.
        5) Attach connections using screws or bolts.
        6) Reinforce fabric if required to keep fabric from collapsing and impacting airflow into fan.

K. Hydronic Coils:
1. Sourcing Option: In lieu of sourcing hydronic coils from a specialty coil manufacturer, air-handling unit manufacturer has option to furnish in-house hydronic coils that achieve equal or better performance while complying with other requirements indicated.
2. General: Provide air-handling units with hydronic coils where indicated on Drawings.
3. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die formed into plate fins.
4. Design and Performance:

    a. Capacities, face area, and number of rows indicated on Drawings are minimum acceptable.
    b. Air pressure drop, water pressure drop, fin spacing, and face velocity indicated on Drawings are the maximum acceptable.
    c. Coils shall be counterflow design, air to fluid. Fluid supply shall enter air leaving side of coil and exit air entering side.
    d. Design coils to be drainable.

        1) Coils shall have all circuits drainable when coils are installed in horizontal position and level.

2) Coil supply and return header shall be furnished with a drain connection at lowest point on header.

e. Design coils to be self-venting.

1) Supply connection near bottom of supply header.
2) Return connection near top of return header.
3) Furnish coil return and supply header with a vent connection at highest point on header.

f. Coils supply and return piping connections on same end of coil.
g. Coils shall be rated for system operating pressures and temperatures encountered by installation, but not less than 200 psig.
h. Coil selection criteria, unless otherwise indicated on Drawings, are as follows:

1) 50% ethylene glycol

2) Face Velocity: Maximum of 500 fpm.
3) Fluid Tube Velocity (at Design Flow Rate):

a) Maximum: 6 fps.
b) Minimum: 3 fps.

4) Fluid Header Velocity: Maximum of 6 fps.

a) Fin Height: Maximum of 48 inches.
b) Fin Spacing: Maximum of 12 fins per inch.

5. Casing and Tube Sheets:

a. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch beyond face of fins on both entering and leaving side.
b. Casing and Tube Sheet Materials:
1) Heating Coils:

a) Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L or Type 316L, No. 2D finish.

c. Top and Bottom Casings:

1) Flange face minimum of 1-1/2 inches; double flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch.
2) Thickness:

a) Coils with Fin Length of up to 72 Inches: Minimum of 16 gauge thick.
b) Coils with Fin Length Exceeding 72 Inches: Minimum of 16 gauge thick.

d. End Tube Sheets:

1) Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2) Flange face minimum of 1-1/2 inches.
3) Thickness: Minimum of 16 gauge thick.

e. Intermediate Tube Sheets:

1) Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2) Space intermediate tube sheets a maximum of 48 inches on center and locate to provide equal spacing between tube sheet across coil tube length.
3) Flange face minimum of 1/2 inch.
4) Thickness: Minimum of 16 gauge thick.

f. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

6. Fins:

a. Materials:

1) Aluminum: 0.0075 inch thick.

b. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
c. Fin Configuration: Flat face fins without ripples.

7. Headers:

a. Construct header of seamless copper, ASTM B75/B75M drawn temper of diameter and wall thickness based on coil size, flow rate, design pressure, design temperature, and circuiting.
b. Tube-to Header Connections: Tube-to-header holes shall intrude inward so landed surface area is three times the core tube thickness, to provide enhanced header to tube joint integrity. Tubes shall evenly extend within the ID of the header no more than 0.12 inch.
c. Header Top and Bottom Caps: End caps shall be die-formed and installed on the ID of header such that the landed surface area is three times the header wall thickness.
d. Drains: Include low point of supply and return header with a NPS 1/2 drain connection. Extend copper pipe through air-handling unit casing and terminate end with male national pipe threads (MNPT). Pipe shall be threaded on both ends to facilitate easy field removal and replacement.
e. Vents: Include high point of supply and return header with a NPS 1/2 vent connection. Extend copper pipe through air-handling unit casing and terminate end with MNPT. Pipe shall be threaded on both ends to facilitate easy field removal and replacement.
f. Supply and Return Connections:

1) Terminate ends with MNPT.

2) Connections to header shall be either copper tube with brazed ASME B16.18 threaded male adapters pipe with machine-threaded MNPT connections. Pipe shall extend through air-handling unit casing and be threaded on both ends to facilitate easy field removal and replacement.
3) Connections NPS 2-1/2 and larger shall have a bronze ASME 16.24 threaded flanges attached to threaded connections to provide for a flanged field connection. Select flange class, Class 150 or Class 300, for system pressure and temperature encountered.

g. Protect openings of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into the coil.

8. Tubes:

a. Material: Copper, ASTM B75/B75M annealed temper or ASTM B280 drawn temper.
b. Tube Nominal Diameter: 1/2 or 5/8 inch before expanding, selected to provide performance indicated.
c. Tube Nominal Wall Thickness: As required by performance, minimum of 0.020 inch thick.

d. Tube Return Bend Nominal Wall Thickness: As required by performance, minimum of 0.025 inch thick.

9. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together and more than 30 percent silver when brazing ferrous to non-ferrous materials.

10. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 or Type 316 stainless steel.

11. Cleaning: Residual manufacturing oils and solid contaminants shall be removed internally and externally by completely submersing the coil in an environmentally acceptable degreasing solution that is chemically compatible with the coil material.
12. Air-Handling Unit Factory Assembly:

a. Coil Connections: Extend each coil connection through casing access panel and terminate connections, approximately 4 inches beyond exterior face of access panel, and seal each penetration as indicated. Casing access panels shall be removed and reinstalled with coils installed inside air-handling units.
b. Internal Access: Include each coil with internal access from downstream and upstream sides as indicated on Drawings.
c. Removal and Replacement: Each coil shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.
d. Supports for Coils:
e. Construct a freestanding and self-supporting structural framework to support each coil individually from and independent of adjacent coils.
f. Construct framework for cooling coils, from stainless steel structural shapes.
g. Construct framework for heating coils from stainless steel structural shapes.

L. DX Coils

1. Sourcing Option: In lieu of sourcing DX coils from a specialty coil manufacturer, air-handling unit manufacturer has option to furnish in-house DX coils that achieve equal or better performance while complying with other requirements indicated.
2. General: Provide air-handling units with DX coils where indicated on Drawings.
3. Description: Plate fin coils constructed of staggered tubes mechanically expanded into continuous collars that are die formed into plate fins.
4. Design and Performance:

    a. Capacities, face area, and number of rows indicated on Drawings are minimum acceptable.
    b. Air pressure drop and face velocity indicated on Drawings are the maximum acceptable.
    c. Coil selection criteria, unless otherwise indicated on Drawings, are as follows:

        1) System Parameters:
            a) Fluid: R-454B
            b) Outdoor ambient temperature: 95 deg F

        2) Face Velocity: Minimum 250 fpm; Maximum of 500 fpm.
        3) Air Pressure Drop: Not to exceed the scheduled value
        4) Refrigerant Pressure Drop: Maximum 13 psi

    d. Cooling coils shall have no moisture carryover at design conditions. Install moisture eliminators on discharge face of coil if it is necessary to eliminate moisture carryover.

5. Casing and Tube Sheets:

    a. Depth: Extend coil casing and tube sheets a minimum of 1/2 inch beyond face of fins on both entering and leaving side.
    b. Casing and Tube Sheet Materials:

        1) Cooling Coils: Stainless steel, ASTM A240/A240M or ASTM A480/A480M, Type 304L or Type 316L, No. 2D finish.

    c. Top and Bottom Casings:

        1) Flange face minimum of 1-1/2 inches; double flange edge for rigidity and ease of removal with secondary flange face minimum of 1/2 inch.
        2) Thickness:

            a) Coils with Fin Length of up to 72 Inches: Minimum of 16 gauge thick.
            b) Coils with Fin Length Exceeding 72 Inches: Minimum of 16 gauge thick.

    d. End Tube Sheets:

1) Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2) Flange face minimum of 1-1/2 inches.
3) Thickness: Minimum of 16 gauge thick.

e. Intermediate Tube Sheets:

1) Tube sheet holes rolled to prevent chaffing of tubes during thermal expansion and contraction.
2) Space intermediate tube sheets a maximum of 48 inches on center and locate to provide equal spacing between tube sheet across coil tube length.
3) Flange face minimum of 1/2 inch.
4) Thickness: Minimum of 16 gauge thick.

f. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

6. Fins:

a. Materials:

1) Aluminum: 0.008 inch thick.

b. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
c. Fin Configuration: Flat face fins without ripples.

7. Headers:

a. Construct header of seamless copper, ASTM B75/B75M drawn temper of diameter and wall thickness based on coil size, flow rate, design pressure, design temperature, and circuiting.
b. Tube-to Header Connections: Tube-to-header holes shall intrude inward so landed surface area is three times the core tube thickness, to provide enhanced header to tube joint integrity. Tubes shall evenly extend within the ID of the header no more than 0.12 inch.
c. Header Top and Bottom Caps: End caps shall be die-formed and installed on the ID of header such that the landed surface area is three times the header wall thickness.
d. Piping Connections:

1) All refrigerant connections shall remain inside the unit cabinet and run directly to the condensing section.

8. Tubes:

a. Material: Copper, ASTM B75/B75M annealed temper or ASTM B280 drawn temper.
b. Tube Nominal Diameter: 1/2 or 5/8 inch before expanding, selected to provide performance indicated.

c. Tube Nominal Wall Thickness: As required by performance, minimum of 0.016 inch thick.

9. Brazing: High-temperature brazing alloy with not less than 5 percent silver when brazing like non-ferrous materials together and more than 30 percent silver when brazing ferrous to non-ferrous materials.

10. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 or Type 316 stainless steel.

11. Cleaning: Residual manufacturing oils and solid contaminants shall be removed internally and externally by completely submersing the coil in an environmentally acceptable degreasing solution that is chemically compatible with the coil material.

12. Air-Handling Unit Factory Assembly:
    a. Internal Access: Include each coil with internal access from downstream and upstream sides as indicated on Drawings.
    b. Removal and Replacement: Each coil shall be independently removable and replaceable through a removable access panel installed in air-handling unit casing.
    c. Supports for Coils:
    d. Construct a freestanding and self-supporting structural framework to support each coil individually from and independent of adjacent coils.
    e. Construct framework for cooling coils, from stainless steel structural shapes.

M. Integral Packaged Air Cooled Refrigeration System

1. General Requirements.
    a. Provide a custom integral air cooled packaged refrigeration system factory piped, wired, charged with nitrogen, charged, and tested with R-454B and oil.
    b. Refrigeration system shall be custom designed to provide energy efficient operation for the specific conditions of this project and performance of each unit.
    c. Construction shall integrate into the unit cabinet using the same quality construction and finishes as the cabinet (detailed in this section). Use of a manufacturer’s standard pre-designed condensing unit or condenser shall not be accepted. Skid mounting of a standard condenser or condensing unit from another manufacturer shall not be accepted.
    d. Use of a refrigerant to water/glycol heat exchanger and fluid cooler for the condenser(s) shall not be accepted due to lower energy efficiency (additional heat exchanger, less efficient heat transfer due to a lack of phase change in the condenser and reheat coils, inefficient glycol required for the working fluid, and the additional maintenance for pumps, expansion tanks, air separator, and the glycol fill).
    e. System shall be factory run tested. The run test shall include the following data at a minimum for each circuit and associated compressor(s), and for both cooling and dehumidification operation:
        1) Verification of compressor crankcase heater operation (where applicable)
        2) Discharge pressure
        3) % of reheat capacity (where applicable)
        4) Liquid pressure, temperature, and subcooling
        5) Suction pressure, temperature, and superheat
        6) Compressor Discharge Temperature
        7) Oil level @ sight glass

8) Amp Draw, % of RLA
9) Outdoor Ambient Temperature and humidity
10) Evaporator Coil Air Temperature Drop
11) Duration of test to achieve steady state prior to data collection (20 minutes minimum)
12) Refrigerant charge shall be adjusted as required to pass both cooling and dehumidification test with the same charge. The run test form with pass/fail criteria for each parameter shall be provided with IOMs upon shipment.

f. Submittal shall include all features as detailed in this section.

2. Outdoor Coil Section Construction:
   a. Outdoor coil section top panel shall be 2" double wall injected foam construction for superior strength and lower vibration. Exterior panel material and finish shall be pre-paint. Interior panel material shall be galvanized. Fan inlets shall be connected to the injected foam top panel.
   b. Outdoor coils and fans for each circuit shall be separated from other circuits by a load bearing 2" double wall injected foam panel constructed of galvanized.
   c. Floor shall be 2" double wall injected foam construction with galvanized top panel. Floor panels shall be sealed to the unit base with industrial adhesive to inhibit water leakage. A galvanized floor pan shall overlay the injected foam panel. A provision for draining moisture to the exterior of the unit shall be provided.
   d. Hail guards/vandalism guards shall be provided for all outdoor coil sections.
      1) For units with angled outdoor coils, screens shall be constructed of expanded aluminum mesh secured to a formed metal frame matching the unit exterior. Screens shall be mounted vertically to protect the coils, compressors, and refrigeration specialties. The screens shall be removable without use of tools and be self-retaining.
      2) For units with vertical outdoor coils, hail guards shall be non-removable expanded aluminum mesh secured to a formed metal frame matching the unit exterior.
3. Minimum System Requirements.
   a. R-454B Refrigerant
   b. Rated Efficiency. Refer to the schedule for the minimum EER requirements for the refrigeration system. Refrigeration systems with EER less than what is scheduled shall be rejected. Provide calculations demonstrating compliance with the specified EER ratings.
   c. Custom Refrigeration System Performance. Provide all parameters demonstrating integrated, balanced performance of the system and resultant capacity at the design airflow including:
      1) Compressor operating envelope for the compressor selected with superheat and subcooling
      2) Outdoor coil details (fins, rows, fin type and thickness, tube diameter, thickness, and type (smooth, rifled) face area, face velocity, and air pressure drop
      3) Indoor coil details (fins, rows, fin type and thickness, tube diameter, thickness, and type (smooth, rifled) face area, face velocity and air pressure drop
      4) Outdoor fan airflow and horsepower
      5) Refrigerant pressure drop for all components and refrigerant line velocity for all piping runs

6) Ambient design temperature and suction and condensing temperatures at design conditions

d. Compressor Protection.
   1) Provide temperature sensors and pressure transducers on both the suction and discharge sides of the system and provide active compressor control logic to keep the compressors in the compressor manufacturer's recommend operating envelope (variable capacity compressors), or "three strikes" compressor protection (fixed capacity compressors).

e. Operating Efficiency
   1) Refrigeration system control logic shall optimize efficiency through control of liquid pressure, condenser airflow and compressor capacity to minimize compressor lift and maximize EER as the load on the system varies.

f. Low Ambient Operating Temperature Cooling. Refrigeration system shall be designed to operate at a minimum outdoor air temperature of 35°F

4. Refrigeration Circuit(s). Provide 4 independent circuits completely pressure tested, dehydrated, and factory charged with refrigerant and oil for shipment. Final charge adjustments during commissioning shall be provided by the installing contractor.
   a. Refrigeration circuits shall be divided between two independently operable electrical sections.
   b. Refrigeration circuits shall be capable of independent operation, diagnostics, service, and maintenance without requiring shutdown of the remaining refrigerant circuits.
   c. DX coils shall be circuited and arranged to correspond with the independent refrigerant circuit configuration.
      1) Refrigeration circuits shall be distributed as evenly as practical across the full coil face area.
      2) Coil circuitry shall provide uniform air temperature distribution during full-load and part-load operation.
      3) Isolation, maintenance, or loss of one or more refrigerant circuits shall not result in excessive air temperature stratification, localized coil freezing, or airflow degradation.
   d. Fan array arrangement shall correspond to the DX coil circuit arrangement.
      1) Fan arrays shall be configured and distributed to ensure uniform airflow across the active coil face area during full-load and part-load operation.
      2) Fan array arrangement and control sequence shall minimize air temperature stratification and airflow imbalance during operation with one or more refrigerant circuits disabled.
      3) Fan array operation shall maintain uniform coil utilization and stable airflow distribution under all operating conditions.
   e. Piping Standards. Pipe systems using the following standards at a minimum:
      1) All brazing shall be done with nitrogen purge to prevent oxidation and scaling
      2) All pipe ends shall be chamfered to limit turbulence, restrictions, and pressure drop. Mandrel-bent piping and long radius copper fittings shall be utilized to limit the number of braze joints and reduce pressure drop
      3) 15% silver filler shall be used for all copper/copper joints
      4) 45% silver and white flux shall be used on all other joints
   f. Provide each refrigeration circuit with the following components:
      1) Filter/Drier: Provide replaceable core type for circuits above 10 tons
         a) Shutoff valves shall be provided on both sides for servicing

2) Liquid line solenoid valve
3) Expansion Valve: Electronic type (EEV) provided for circuits with VFD compressors, Thermal type (TXV) for all others
    a) EEV shall have a dedicated superheat controller
4) Anti-cycle function
5) Manual Reset High Pressure Switch
6) Auto Reset Low Pressure Switch
7) Refrigerant suction, discharge, and liquid pressure transducers and suction and discharge temperature sensors shall be provided and wired to the main controller. Superheat and subcooling values shall be calculated and available for local or remote diagnostics
8) Service/charging valves. Provide at a minimum discharge line, suction line, and liquid line service/charging valves
9) A receiver with sight glass shall be provided on circuits with hot gas reheat coils or circuit with low ambient controls
    a) Provide a pressure relief valve for the receiver.
10) Shutoff valves shall be provided on both sides of compressors for servicing when shown on the plans.

5. Compressors.
    a. Provide hermetic scroll compressor(s) as specified in this section.
    b. Provide compressors for each circuit as follows:
        1) Circuit 1, Digital Tandem (1 Digital + 1 Staged)
        2) Circuit 2, Digital Tandem (1 Digital + 1 Staged)
        3) Circuit 3, Digital Tandem (1 Digital + 1 Staged)
        4) Circuit 4, Digital Tandem (1 Digital + 1 Staged)
    c. Compressor Technology. Compressors shall meet the following requirements:
        1) Digital Scroll. Provide compressors capable of an operating range from 100% down to 10% of the full refrigeration system capacity as manufactured by Emerson (Copeland).
            a) Provide scroll compressors with reverse rotation protection, sight glass with moisture indicator (TXV), and oil level adjustment
            b) Provide and mount and wire the controller(s) from the compressor manufacturer to control operation of the digital compressor(s).
            c) Compressors shall be mounted on rubber isolators
        2) Fixed Speed Scroll. Piping for tandem compressors shall be engineered and provided by the compressor manufacturer, and the performance shall be specifically provided for the tandem set.
            a) Provide scroll compressors with reverse rotation protection, sight glass with moisture indicator (TXV), and oil level adjustment.
            b) Compressors shall be mounted on rubber isolators.
6. Outdoor Coils
    a. Standard of Quality. Provide copper tube/aluminum fin coils as manufactured by Precision Coils, Modine, or Direct Coil meeting all construction features and performance parameters as specified in this section. Microchannel condenser coils shall not be used due to the extremely dense fin spacing required and inability to repair leaks, requiring replacement of the entire coil.
    b. Construction. Provide coils with the following material types and thicknesses:
        1) Tubes: 0.012" thick seamless copper tubes w/ rifled interior
        2) Fins: 0.006" thick aluminum lanced fins
        3) Tube Diameter: 5/16"

4) Casing: Galvanized
5) Provide an integral subcooler circuit to ensure a minimum of 10 degrees of liquid subcooling

c. Performance. Provide coils meeting the following performance parameters:
1) Outdoor Design Ambient Temperature: 95°F
2) Outdoor Coil Airflow
3) Face Velocity: Maximum 600 fpm, but not to exceed the scheduled value
4) Air Pressure Drop: Not to exceed the scheduled value
5) Refrigerant Pressure Drop: Maximum 13 psi including outdoor coil subcooler section
6) Heat Transfer Surface:
a) Rows: Provide the number of rows scheduled
b) Fin Density: Maximum 16 fins/inch, but not to exceed the number of fins/inch scheduled

7. Outdoor Fans/Motors:
a. Standard of Quality. Fans shall be Ziehl-Abegg EC Blue with construction details as specified below.
b. Wheel. The fan wheel shall be axial type. Wheel shall be statically and dynamically balanced.
1) The wheel shall be constructed of composite material. FE2 Owlet blade shall be sickle-shaped with serrated edge and a winglet.
c. Construction:
1) Fan panels shall be powder coated steel with formed flanges, pre-punched mounting holes, and full bellmouth provided for optimized performance.
2) Accessories: Provide powder-coated steel wire fan guard.
d. Motor. Motors shall be direct drive 1200 rpm maximum, external rotor EC (electronically commutated), as described in this section:
1) Motor shall be an external rotor, electronically commutated type with integral variable speed controller. Motor shall be UL and CE approved.
e. Performance:
1) Fan motor horsepower shall not exceed the scheduled outdoor fan horsepower.
2) Provide the number of fans scheduled, no exceptions.
3) Fan performance shall be tested for airflow and sound in an AMCA certified test lab.

N. Drain Pans:

1. General:

a. Include a drain pan for each cooling coil and at other locations indicated.
b. Continuously weld drain pan seams, joints, and mitered corners to make the assembled drain pan watertight.
c. Drain pans shall be located under the entire coil and provide full coil coverage including coil return bends and headers.
d. Slope drain pans in multiple directions toward low point drain connection at a uniform slope of at least 1 percent from high point to low point.
e. Include stainless steel blank-offs to prevent air from bypassing around coil.

2. Intermediate Drain Pans:

a. Where multiple individual horizontally mounted coils are vertically stacked to make a coil bank, install intermediate drain pans under each stacked coil in the coil bank.
b. Material: Type 304L, Type 316L, 300 series stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge thick.
c. Minimum Depth: 1.5 inches.
d. Extend drain pan beyond air leaving face of coil casing at least 12 inches.

1) Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of leaving face of coil.

e. Drain Pan Connection:

1) Stainless steel threaded coupling welded to underside of drain pan at lowest point.
2) Minimum Nominal Connection Size: NPS 1.5.

f. Drain Pipe:

1) Air-handling unit manufacturer to connect full-size drain pipe to each drain pan connection. Option to use one of following pipe materials:

a) Copper tube with a bronze threaded male adapter, brazed or solder to end.

2) Extend drain pipe to top of drain pan immediately below.
3) Include a removable stainless steel support to secure bottom of drain pipe from drain pan below to prevent lateral movement.
4) In applications where multiple drain pans are stacked, align stacked drains pan connections and pipes for clear vertical flow.

3. Bottom Drain Pans:

a. Mounting Location, Recessed in Floor: Air-handling unit manufacturer has option to recess bottom drain pan into the floor or install drain pan above air-handling unit floor walking surface.
b. Mounting Location, Above Floor: Bottom drain pan shall be installed above air-handling unit floor walking surface. Do not recess drain pan into unit base.
c. Grating: Install removable stainless steel grating on top of drain pan.
d. Double-Wall Construction: Double-wall sheet with space between walls filled with 1-inch insulation.
e. Material: Type 304L, Type 316L, 300 series stainless steel ASTM A240/A240M or ASTM A480/A480M, a minimum of 16 gauge thick.
f. Minimum Depth: 1.5 inches.
g. Extend drain pan beyond air leaving face of coil casing at least 12 inches.

1) Where moisture eliminators are required to prevent moisture carryover, extend drain pan beyond leaving face of moisture eliminator in lieu of the leaving face of coil.

h. Drain Pan Connection:

1) Stainless steel threaded half-coupling welded to lowest point of drain pan.
2) Location: both ends.
3) Minimum Nominal Connection Size: NPS 1.5.

i. Drain Pipe:

1) Air-handling unit manufacturer to connect full size drain pipe to each drain pan connection. Option to use one of following pipe materials:

a) Copper tube with threaded male adapter, brazed or soldered to ends.
b) Aluminum pipe with threaded MNPT ends.
c) Stainless steel pipe with threaded MNPT ends.

2) Extend drain pipe and terminate 3 inches beyond exterior face of casing.

O. Pleated Panel Filters:

1. Description: Factory-fabricated, self-supported, extended-surface, pleated, panel-type, disposable air filters.
2. Performance:

a. Filtration Efficiency, ASHRAE 52.2 MERV Rating: 13.

b. Initial Air Pressure Drop: With face velocity of 500 fpm, clean filter pressure drop shall not exceed the following:

1) MERV 13:

a) Depth 4 Inches (50 mm): 0.31 inch wg.

c. Manufacturer-Recommended Final Air Pressure Drop: 1.0 inch wg.
d. Pressure Differential without Failure: 2 inches wg.
e. Temperature Rating: 200 deg F.

3. Certification:

a. AHRI: Tolerances in accordance with AHRI 850 (I-P) and AHRI 851 (SI).
b. ASHRAE: Tested and rated in accordance with ASHRAE 52.2.
c. UL: UL 900 listed.

4. Size:
a. Nominal Filter Size:

1) Face: 24 by 24 inches.
2) Depth: 4 inches.

b. Actual Filter Size: Suitable for installation in an industry-standard filter holding frame.

5. Filter Media Surface Area: Each filter shall contain the following minimum media surface area for a filter with a nominal 24-by-24-inch face:
   a. Depth 4 Inches (100 mm): 17.3 sq. ft.

6. Construction:

   a. Media: Glass or Cotton and synthetic blend of fibers arranged in a series of pleats attached to and supported by a corrosion-resistant welded-wire grid.
   b. Filter Media Casing: High wet strength (28-point) beverage board that is bonded around the periphery to eliminate air bypass.

      1) Diagonal support members across upstream and downstream filter face constructed of same material as casing shall ensure pleat spacing and stability.

   c. Adhesive: Fire-retardant bonding adhesive where bonding media to casing.

P. ASHRAE-Rated Filter Holding Frames:

1. Filter Holding Frames for ASHRAE-Rated Filters:

   a. Fabricate filter holding frames with mitered corners and reinforce frame to maintain a durable, rugged, true square shape.
   b. Construct frames of galvanized steel. Use stainless steel frames in applications exposed to corrosive airstreams.
   c. For applications with pre-filter and final filters sharing the same filter holding frame, frames shall be suitable for supporting and holding both pre-filter and final filters in frame with both filters serviceable from upstream (entering air) side.
   d. Frame Depth: At least 4.75 inches.
   e. Gaskets: Continuous, suitable for same operating temperature as filters.
   f. Filter Clips: Each filter holding frame with spring clip fasteners at each corner. Spring clips shall allow filters to be removed and replaced without use of tools.
   g. Frames shall be industry-standard size to provide interchangeability of filters from other manufacturers.

2. Air-Handling Unit Factory Installation:

   a. Air-handling unit manufacturer shall furnish filters and provide filter holding frames, retaining clips, and filter support structures.
   b. Furnish filter quantity, size, type, and performance indicated on Drawings.
   c. Install filter frames in a flat vertical position for horizontal airflow.
   d. Install holding frames in accordance with manufacturer's written instructions and to prevent passage of unfiltered air. Include additional gaskets as necessary.
   e. Secure individual holding frames together to build a multiple filter bank.
   f. Construct galvanized-steel support structure to hold frames and filters.

1) Design support structure for maximum system operating pressures encountered equal to fan shutoff pressure.
2) Design and fabricate support structure to limit deflection across filter bank to 1/360 of the span when subjected to a 200-lb lateral force applied at any point on the filter holding frame assembly.

Q. Filter Gauges:

1. Provide a gauge to indicate pressure differential between entering and leaving side of each filter bank. Panel filter bank separate from cartridge filter bank.

    a. Where multiple filters share a common frame, include a separate gauge for each filter bank.
    b. Include a metal spacer constructed of same material as filter frame for one of the filters installed in filter bank to accommodate pressure differential measure across both upstream and downstream filters.

2. Gauge shall have a nominal 4-inch-diameter face.
3. Select range of gauge to be approximately twice the dirty filter pressure drop.
4. Provide each gauge with vent valves to allow for re-zeroing the gauge without removing tubing connections.
5. Include static pressure sensors on entering and leaving side of each filter bank.
6. Air-Handling Unit Factory Assembly:

    a. Mount each filter gauge on exterior surface of unit casing near associated filter sections.
    b. Mount center of gauges 60 inches above bottom of air-handling unit structural base.
    c. Connect static pressure sensors to filter gauges using stainless steel tubing and compression type fittings.
    d. Support tubing at intervals not greater than 60 inches o.c.

R. Automatic Dampers:

1. General: Provide air-handling units with automatic dampers where indicated on Drawings.

    a. Unless otherwise indicated, use parallel-blade configuration for two-position control, for equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
    b. Factory assemble multiple damper sections to provide a single damper assembly of size required by application.
    c. Damper actuator shall be factory installed by damper manufacturer as integral part of damper assembly. Coordinate actuator location and mounting requirements with damper manufacturer.

2. Industrial-Duty Rectangular Dampers with Steel Airfoil Blades:

    a. Greenheck

b. Ruskin

c. T.A. Morrison
d. Performance:

1) Leakage: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
2) Pressure Drop: 0.06 inch wg at 2000 fpm across a 48-by-48-inch damper when tested in accordance with AMCA 500-D, figure 5.3.
3) Velocity: Up to 4000 fpm.
4) Temperature: Minus 40 to plus 250 deg F.
5) Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length, minimum 10 inches wg.

e. Construction:

1) Frame:

a) Material: Galvanized steel, minimum 0.11 inch thick.
b) C-shaped channel with mating face minimum of 1 inch.
c) Width not less than 3 inches.

d) Width not to exceed 6 inches.
e) Length not to exceed 48 inches.

2) Seals:

a) Blades: Replaceable, mechanically attached EPDM or extruded silicone.
b) Jambs: Stainless steel, double compression type.

3) Axles: 0.5- or 0.75-inch-diameter plated steel, mechanically attached to blades and continuous from end to end.
4) Bearings:

a) Stainless steel sleeve type mounted in frame.
b) Where blade axles are installed in vertical position, provide thrust bearings.

5) Linkage:

a) Face linkage exposed to airstream.
b) Constructed of plated steel.
c) Hardware: Type 304 or Type 316 stainless steel.

3. Damper Actuators:

a. General:

1) Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which damper is subjected.
2) Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.
3) Total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.
4) Include one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.
5) Avoid use of excessively oversized actuators, which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.
6) Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.
7) Include mounting hardware and linkages for connecting actuator to damper.
8) Select actuators to fail in desired position in the event of a power failure.
9) Actuator Fail Positions: As indicated below:

a) Exhaust Air: Close.
b) Outdoor Air: Close.
c) Supply Air: Open.
d) Return Air: Open.

b. Type: Motor operated, with or without gears, electric and electronic.
c. Voltage:

1) Voltage selection is delegated to professional designing control system.
2) Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3) Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

d. Construction:

1) Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2) 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3) Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

e. Field Adjustment:

1) Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.

2) Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when actuator is not powered.

f. Two-Position Actuators: Single direction, spring return, or reversing type.

g. Modulating Actuators:

1) Capable of stopping at all points across full range and starting in either direction from any point in range.
2) Control Input Signal:

a) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for 0- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
b) Pulse-Width Modulation (PWM): Actuator drives to a specified position in accordance with a pulse duration (length) of signal from a dry-contact closure, triac sink, or source controller.
c) Programmable Multifunction:
d) Control input, position feedback, and running time shall be factory or field programmable.
e) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
f) Service data, including at a minimum, number of hours powered, and number of hours in motion.

h. Position Feedback:

1) Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2) Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3) Include a position indicator and graduated scale on each actuator indicating open and closed travel limits.

i. Fail-Safe:

1) Where indicated, provide actuator to fail to an end position.
2) Internal spring return mechanism to drive-controlled device to an end position (open or close) on loss of power.
3) Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

j. Integral Overload Protection:

1) Provide against overload throughout the entire operating range in both directions.
2) Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

k. Damper Attachment:

1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3) Bolt and setscrew method of attachment is acceptable only if included with at least two points of attachment.

l. Temperature and Humidity:

1) Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2) Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, noncondensing.

m. Enclosure:

1) Suitable for ambient conditions encountered by application.
2) Provide actuator enclosure with a heater and controller where required by application.
3) NEMA 250, Type 2 for all applications except.
4) NEMA 250, Type 4 or Type 4X for applications.

n. Stroke Time: Select operating speed to be compatible with equipment and system operation.

1) Operate damper from fully closed to fully open within 60 seconds.
2) Operate damper from fully open to fully closed within 60 seconds.
3) Move damper to failed position within 15 seconds.
4) Actuators operating in smoke-control systems shall comply with governing code and NFPA requirements.

o. Sound:

1) Spring Return: 62 dBA.
2) Non-Spring Return: 45 dBA.

S. Air-Handling Unit Factory Drain Piping And Piping Insulation:

1. General:

a. Air-handling unit manufacturer to factory install piping inside air-handling units.
b. If more than one material is listed, material selection is by air-handling unit manufacturer.

2. Copper Tubing:

a. Tubing: Drawn-temper, ASTM B88, Type L.
b. Fittings: Wrought-copper and copper alloy, ASME B16.22, pressure fittings.

c. Unions: Cast-copper-alloy, MSS SP-123, hexagonal-stock body; female NPT threaded ends.
d. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux in accordance with ASTM B813.

3. Drain Pan Piping:

a. Copper tube with soldered threaded male adapters.
b. Factory install drain piping for drain pan(s). Install a dedicated drain pipe for each drain pan serving different air-handling unit internal components. Where multiple drain pans serve like components interconnect drain piping to a single drain pipe for field connection.

1) Where interconnecting cooling coil condensate drain pans from upstream and downstream sides of cooling coil, provide pipe with a water seal trap configured to prevent air bypass.
2) Terminate pipe with a threaded pipe cap 3 inches beyond exterior face of air-handling unit casing. Threaded pipe cap material to match pipe material.
3) Drain pipe size to match size of drain pan connection.

4. Piping Insulation:

a. Factory insulate bottom cooling coil drain pan pipe with 1-inch- thick, flexible elastomeric insulation where pipe is located under and outside of the air-handling unit casing but within the air-handling unit base.
b. Cover pipe insulation with a factory-applied aluminum or stainless steel jacket.

T. Air-Handling Unit Factory Hydronic Piping and Piping Insulation:

1. Heating Water Piping:

a. Design Pressure and Temperature: 200 psig, 325 deg F .
b. Pipe: ASME B36.10M, carbon steel ASTM A53/A53M, with beveled or plain ends; electric resistance weld or seamless longitudinal joints, Grade B; standard weight.
c. Fittings, Threaded: Malleable iron, ASME B16.3; Class 150.
d. Fittings, Butt Welded: ASME B16.9, wrought-steel ASTM A234/A234M, Grade WPB, seamless or welded, wall thickness to match adjoining pipe.
e. Flanges, Weld: Weld-neck, forged carbon-steel, ASME B16.5; Class 150.
f. Unions, Threaded: Malleable iron, ASME B16.39; Class 150.
g. Strainers: Y-pattern; body and cap constructed of cast-iron, ASTM A126, Class B, removable basket constructed of Type 304 or Type 316 stainless steel with openings not larger than 0.032 inch; Class 125.
h. Valves:

1) Ball: Two-piece with threaded ends, MSS SP-110, 600 WOG; cast-bronze or forged copper-alloy body, stainless steel vented ball, corrosion-resistant plastic-coated handle, and extended stem.
2) Butterfly: Lugged body; MSS SP-67; cast-iron, ductile-iron, or cast-steel body; stainless steel disk, EPDM seat, and lever operator; rated for system

pressure, but not less than 250-psig bi-directional dead-end shutoff with downstream flange removed.

3) Check: Globe-style, MSS SP-125; cast-iron ASTM A126 body, stainless steel spring, and bronze seat; Class 125.

i. Vents: Cast-iron body, stainless steel float, NPS 1/2 or larger inlet connection.

j. Flow Meters: In-line electromagnetic type with integral display and accuracy within 3 percent of reading.

k. Pressure Gauges: Bourdon-tube, ASME B40.100 with Grade B accuracy; metal case with nominal 4-1/2-inch shatter-resistant glass face and NPS 1/2 threaded brass connection.

l. Test Plugs: Brass or stainless steel body with core inserts and gasketed and threaded cap, extension for insulation; threaded NPS 1/2 connection.

m. Thermometers: Bi-metal actuated, ASME B40.200 with 1 percent accuracy; adjustable-angle stainless steel case with nominal 5-inch shatter-resistant glass face. Include thermometers with stainless steel extended-neck thermowells.

n. Air-Handling Unit Factory Assembly: Factory install a complete piping system inside air-handling units as indicated on Drawings.

1) NPS 2 and smaller with threaded fittings, strainers, and valves. Larger sizes with welded joints, fittings, and flanges for valves and strainers.
2) Arrange piping with sufficient clearance between piping and other components to accommodate removal and replacement of installed components.
3) Gradually slope piping for venting and drainage.
4) Include threaded drain connections and ball valves with threaded hose-end, cap, and chain at all low points in piping.
5) Comply with requirements indicated on Drawings.
6) Make connections to coils with a flange.
7) Connect to each coil inlet with shutoff valve, test plug, strainer, pressure gauge and thermometer.
8) Connect to each coil outlet with balancing valve, test plug, pressure gauge, thermometer and shutoff valve.
9) Connect each coil drain connection with a drain valve, which is full size of drain connection.
10) Connect each coil vent connection with automatic or manual vent, which is full size of vent connection.
11) Include each strainer with a blowdown connection consisting of a nipple and threaded ball valve with threaded hose-end, cap, and chain.

2. Heating Water Piping Insulation and Identification:

a. Insulation: Preformed, cellular glass; minimum 2 inches thick.

b. Adhesive: Compatible with insulation material and recommended in writing by insulation manufacturer.

c. Jacket: Aluminum, smooth, 0.020 inch thick.

d. Air-Handling Unit Factory Assembly: Continuously insulate and seal piping insulation system throughout its entire length.

1) Install high-density insulation insert products, consisting of two 180-degree halves, at pipe hangers and supports. Material density sufficient to accommodate loading without deformation.
2) Insulation thickness determined by air-handling unit manufacturer to comply with governing codes, ASHRAE/IES 90.1, and minimum thickness indicated and to prevent condensation.
3) Insulate piping system only after successful completion of pressure tests.
4) Install adhesive-backed acrylic identification labels indicating service and direction of flow at multiple locations sufficient for operators to easily follow the flow path. Each branch pipe should have at least one label.

3. Piping Hangers and Supports:

a. Finish: Galvanized metallic coatings including pre-galvanized, hot-dip galvanized, or electro-galvanized.
b. Hangers: MSS-SP-58, Type 1.
c. Supports: MSS-SP-58, Type 4, Type 24, or Type 37.
d. Threaded Rods: Continuous-thread rod, nuts, and washer made of galvanized steel or stainless steel.
e. Strut: MFMA-4, continuous slotted stainless steel, Type 304 channel with in-turned lips.
f. Air-Handling Unit Factory Assembly:
g. Ridgely support piping from internal structure in accordance with governing codes and MSS SP-58.

U. Factory-Assembled Electrical:

1. Factory install UV-C and switches, service light fixtures and switches, and receptacles for each air-handling unit.

a. Locate in a convenient and field-accessible location.
b. Installation shall comply with NFPA 70.
c. Wire, Conduit, and Enclosures:

1) Minimum Conduit Size: 3/4 inch.
2) Materials: Metal, with a corrosion-resistant finish.
3) Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware constructed of stainless steel.
4) Conduit: Locate conduit inside the air-handling unit casing. Conduit installed on exterior of air-handling unit casing is unacceptable.
5) Wire: Copper, rated for 600 V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
6) Minimum Wire Size: No. 12 AWG.
7) Each circuit shall have a ground wire.
8) Install wire in conduit.

d. Boxes, Conduit Outlet Bodies, and Enclosures:

1) Located in Airstream: NEMA 250, Type 4X.
2) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.

e. Seals: Seal pathways to prevent air leakage between air-handling unit exterior and interior, and between internal component sections.
f. UV-C Lamp System Applications: Wire all UV-C lamp systems located in the same air tunnel to a single circuit.
g. Service Lighting Applications:

1) Provide quantity of 20-A branch circuits required to power service light fixtures.
2) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
3) Factory install a main disconnect switch for interfacing air-handling power for service lighting with single-point field power wiring connection.

h. Receptacle Applications:

1) For air-handling units consisting of multiple stacked tiers, provide separate circuits for top and bottom tiers of air-handling units.
2) Factory wire receptacles to a main disconnect switch for interfacing air-handling power for receptacles with a single-point field power wiring connection.

2. Main Disconnect Switches: Factory-install main disconnect switch mounted on air-handling unit casing exterior for interface of factory power wiring with field power wiring.

a. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
b. Three pole, fused or nonfused.
c. 600 V rated.
d. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 Insert value A.
e. Enclosure:
1) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.

f. Operating handle shall be of box-mounted type that directly drives switch mechanism.
g. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
h. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
i. Include a solid neutral as required by authorities having jurisdiction.
j. Disconnect switch shall have a ground lug for ground wire termination.
k. Operating handle shall be lockable in open position.
l. Horsepower rated.
m. Feed through or double lugged.

3. Exterior Service Light Fixtures:

a. LED Luminaires for Outdoors:
   1) Finish: Selected by Architect from available finishes offered by manufacturer.
   2) Mounting: Wall.
   3) Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
   4) Light Color: 4000 K.
   5) Light Output: 6000 lumens.
   6) Additional Protection: Vandal guard or wire guard.
   7) On/Off Operation: Local toggle switch.

b. Vapor-tight Fixtures:
   1) Finish: Selected by Architect from available finishes offered by manufacturer.
   2) Mounting: Wall.
   3) Intended for direct exposure in outdoor locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
   4) Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
   5) LED A21 Series Lamps:

      a) Light Color: 5000 K.
      b) Light Output: 1700 lumens.

c. Application:
   1) Provide one service light fixture on each side of air-handling unit with access doors. Position fixture at midpoint of most remote access doors.

4. Interior Service Light Fixtures:

   a. Vapor-tight Fixtures:
      1) Suitable for wet locations and operation in cold- and hot-temperature extremes encountered; dust and moisture resistant.
      2) Cast-aluminum housing and guard with heat-resistant, tempered, clear glass globe.
      3) LED A21 Series Lamps:

         a) Light Color: 5000 K.
         b) Light Output: 1700 lumens.

   b. Application:
      1) Provide one service light fixture in each accessible section of air-handling units.

5. Toggle Switches for Service Light Fixtures:

   a. Single-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

   b. Toggle Switch Box and Cover: Mount toggle switch in a metal outlet box with stainless steel cover. Weatherproof where exposed to outdoors.

c. Application:

1) Factory install switching configuration (single, three way, or four way) required to operate a single service light fixture or group of service light fixtures from any access door that opens to respective service light fixtures.
2) Factory install a service light switch for each service light fixture or group of service light fixtures accessible from a single access door adjacent to the access door.

6. Receptacles:

a. Duplex GFCI Receptacles, 125 V, 20 A:

1) Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2) Configuration: NEMA WD 6, Configuration 5-20R.
3) Type: Non-feed through.
4) Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

b. Receptacle Box and Cover: Mount receptacle in a metal outlet box with stainless steel cover. Weatherproof where exposed to outdoors.
c. Applications: Factory install a receptacle in a convenient and field-accessible location on air-handling unit exterior of casing near access doors accessing electric heaters and fans.

7. Power Supply to Fan Motors:
a. Factory install one variable-frequency controller for each independently operable half of the fan array.

1) Locate in a convenient and field-accessible location on unit exterior.
2) Installation shall comply with NFPA 70.
3) Wire, Conduit, and Enclosures:

a) Minimum Conduit Size: 3/4 inch.
b) Materials: Metal, corrosion resistant.
c) Motor Termination: Flexible conduit, NRTL listed, not to exceed 36 inches long.
d) Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware constructed of stainless steel.
e) Wire: Copper, rated for 600 V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
f) Minimum Wire Size: No. 12 AWG.
g) Each circuit shall have a ground wire.
h) Install wire in conduit.

4) Boxes, Conduit Outlet Boxes, and Enclosures:

a) Located in Airstream: NEMA 250, Type 4X.
b) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.

8. Disconnect Switches:

    a. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
    b. Three pole, fused or nonfused.
    c. 600 V rated.
    d. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 A.
    e. Enclosure:
        1) Located on Exterior of Air-Handling Unit Casing: NEMA 250, Type 4X.

    f. Operating handle shall be of box-mounted type that directly drives switch mechanism.
    g. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
    h. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
    i. Include a solid neutral as required by authorities having jurisdiction.
    j. Disconnect switch shall have a ground lug for ground wire termination.
    k. Operating handle shall be lockable in open position.
    l. Horsepower rated.
    m. Feed through or double lugged.

9. Variable-Frequency Controllers:

    a. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.

    b. VFD enclosure shall be NEMA 12 minimum and installed in the unit vestibule Externally Operated Disconnect: Fused disconnect switch with lockable handle.
    c. Minimum Short-Circuit Current Rating: As required by electrical power distribution system, but not less than 65,000 A.
    d. Technology: Pulse-width-modulation (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
    e. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.
    f. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
    g. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
    h. Operating Requirements:

        1) Input AC Voltage Tolerance: 10 percent.
        2) Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
        3) Capable of driving full motor load, without derating.
        4) Minimum Efficiency: 96 percent at 60 Hz, full load.
        5) Minimum Displacement Primary-Side Power Factor: 95 percent.
        6) Overload Capability: 1.05 times the full-load current for 7 seconds.

7) Starting Torque: As required by fan and motor drive assembly.
8) Speed Regulation: 1 percent.
9) Speed Range: 10:1 speed range.
10) To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
11) Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

i. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
j. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or need for replacement:

1) Surge suppression.
2) Loss of input signal protection.
3) Critical frequency rejection.
4) Overtemperature.
5) Short circuit at controller output.
6) Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
7) Open circuit at controller output.
8) Input undervoltage.
9) Input overvoltage.
10) Loss of input phase.
11) Reverse phase.
12) AC line switching transients.
13) Instantaneous overload, line to line or line to ground.
14) Sustained overload exceeding 100 percent of controller rated current.
15) Starting a rotating motor.

k. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
l. Automatic Reset and Restart:

1) Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
2) Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

m. Visual Indication: On face of controller; indicating the following conditions:

1) Power on.
2) Run.
3) Overcurrent and overvoltage.
4) Motor speed (percentage).
5) Various faults with alarm status.
6) Input kilovolt amperes.

7) Power factor.
8) Input kilowatts and kilowatt-hours.
9) Three-phase input and output voltage.
10) Three-phase input and output current.
11) Output frequency.
12) Elapsed operating time (hours).
13) Diagnostic and service parameters.

n. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
o. Hardwired Control Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4 to 20 mA) and four programmable digital inputs.
p. Remote Communication Interface: ASHRAE 135 BACnet MS/TP.
q. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

4) Type: Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
5) Arrangement: Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
6) Enclosure: Install bypass controller in same enclosure as variable-frequency controller.
7) Remote Monitoring: Include control relay for remote indication of bypass controller operation.

V. Lockout/Tagout (LOTO) and Concurrent Maintainability
1. Air-handling unit shall be divided into a minimum of two independently isolated power sections.
2. Each power section shall have a dedicated power connection and disconnecting means.
3. Refrigeration circuits, fans, and electric heat (where provided) shall be distributed between the power sections such that isolation of one section allows continued operation of the remaining section.
4. Isolation of one power section for maintenance shall maintain not less than 50 percent of scheduled airflow and cooling capacity.
5. Factory wiring shall be arranged to permit safe lockout/tagout of one power section to allow maintenance, repair, or replacement of a failed compressor without requiring shutdown of the entire unit.
6. Control architecture may utilize a common controller provided the controller remains capable of monitoring and operating the remaining energized equipment when one power section is isolated.

W. DDC System
1. Manufacturer shall provide a programmable digital control system for each custom unit. A user terminal with LCD display shall provide capability of monitoring operation and

changing setpoints through an integral keypad. The user terminal shall be capable of being either unit mounted (UUT) or remote mounted (RUT) using straight through six wire flat cable. The manufacturer shall program the sequence of operation as specified in this section. The program shall include the following:

a. Unit start-up and shut-down requirements including fan/airflow proving indication and damper actuator end switch indication.
b. Temperature control for all heating and cooling devices.
c. Humidity control for all dehumidification devices and processes.
d. Economizers (dry-bulb, enthalpy, dewpoint, energy recovery) where applicable.
e. Fan controls for each mode of operation.
f. Requirements for modes of operation other than Normal Occupied mode.
g. Integration of all optional devices (firestats, smoke detectors, pressure transducers, airflow stations, etc.) specified in this section.
h. Alarms:
    1) Informational auto-reset alarms shall be provided and stored for all sensors, end devices, and components, and shall be accessible through the controller user interface.
    2) Manual reset alarms shall be provided as specified for some optional devices (e.g. firestats, freezestats, smoke detectors, fan duct static pressure limits) and where required to protect the space served or the equipment.
    3) A list of standard alarms available to the BAS shall be included in the points list as specified in this section.
    4) Pressure control for VAV system. Supply fan duct static pressure sensor shall be provided by the equipment manufacturer. Exhaust fan space/adjacent space differential pressure sensor shall be provided by the equipment manufacturer (mounted by installing contractor).

2. The controller shall communicate with the Building Automation System (BAS) through a factory provided BACnet MS/TP interface card. A points list necessary to control the equipment, perform the sequence of operation, and informational points required by the BAS shall be provided as specified in this section.

3. The controller shall have the capability through a web-based User Interface to remotely monitor all inputs/outputs, control the user terminal, view status of all alarms including both alarm and cleared time stamps, remotely upload a new program, and view historical and live log data for the past 24 hours. The controller shall save the log data for a rolling 7 days in a csv file that can be downloaded, with the additional capability of storing 31 days of logged data to an external thumb drive.

4. Alarm Indication. DDC controller shall have one digital output for remote indication of an alarm condition. (i.e. Blower current switch, differential pressure switch, damper end switch, supply discharge low limit, freeze stat, fire stat, smoke, dirty filters…). Alarm Indication shall be configurable to indicate only shut down alarms if desired. The type of alarm shall be distinguishable through the BMS.

5. The Equipment manufacturer shall provide the following refrigeration system compressor protections:

    a. Cycle Time (minimum OFF and minimum ON).
    b. High Saturated Discharge Temperature.
    c. Low Saturated Suction temperature.

d. High Pressure Trip (manual reset).
e. Low Pressure Trip.
f. High Discharge Temperature.

6. Airflow Stations. Provide airflow measurement stations as follows:
   a. Damper Airflow Measuring Station. Greenheck AMS. Airflow measurement stations shall be provided integral to the following control dampers:
      1) Minimum Outside Air Damper
         a) Flow Straightener: Polycarbonate honeycomb
         b) Accuracy: 5% of airflow
         c) Velocity Range: 300 fpm to 2000 feet per minute
         d) Sleeve: 12' long, constructed of galvanized steel
         e) A pressure transducer and controller shall be provided by the unit manufacturer to measure and maintain the airflow setpoint, receiving a 0-10 VDC signal from the Unit Controller or BMS and returning the proportional CFM indication.
         f) Provide Greenheck model AMD-23 or Ruskin model IAQ50X.
      2) Fan Airflow Monitoring Station. Greenheck Sure-Aire:
         a) Supply Fans; Return Fans;
         b) Airflow monitoring station shall monitor the pressure difference between the fan inlet and the smallest diameter of the inlet cone.
         c) Volumetric flow shall be calculated from empirically derived formulas based on testing by the fan manufacturer.
         d) Airflow monitoring station shall not use air restricting flow devices at the fan inlet that reduce fan performance or create additional fan sound.
         e) Equidistantly spaced sensor orifices shall be drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall be extended to a termination plate mounted on the fan housing.
         f) High-pressure flow port(s) shall be mounted in low velocity fan inlet. Flow ports from the high-pressure sensor shall extend to a termination plate mounted on the fan housing.
         g) Termination plate shall include a low-pressure connection, a high-pressure connection and a listing of the empirically determined flow rate coefficient.
         h) Airflow monitoring station shall accurately measure the pressure differential to within +/-3%.
         i) Airflow monitoring station shall be installed by the fan manufacturer as part of the standard fan assembly.
7. Miscellaneous Controls:
   a. Filter pressure switches shall be provided across each filter rack
   b. Filter pressure transducers shall be provided across each filter rack.
   c. Condensate drain pan switch shall be provided for all drain pan
8. All HW valves and actuators shall be provided and installed by others.
9. Sequence of Operation. Manufacturer shall provide the sensors required for the Sequence of Operation, including additional points listed in the BMS Points listed when included in this section. The sequence of operation shall incorporate devices such as smoke detectors, filter switches or transducers, and kill switches specified in the Electrical section of this equipment specification.

X. Smoke Detectors:

1. System, Duct Smoke Detectors: Photoelectric type complying with UL 268A and listed for compatibility with the existing Edwards EST4 fire alarm system. UL 268A covers detectors that are part of a fire-alarm system and detectors intended solely for control of releasing devices such as dampers.

    a. Operating at 24-V dc, nominal.
    b. Detectors shall be four-wire type.
    c. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
    d. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
    e. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
    f. Provide multiple levels of detection sensitivity for each sensor, with alarm-verification feature.
    g. Duct Smoke Detectors: Photoelectric type complying with UL 268A and compatible with a Edwards EST4 system

        1) Remote indication and test station. Operating key switch initiates an alarm test.
        2) Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC systems.
        3) Sampling Tubes: Design and dimensions as recommended by manufacturer for specific size, air velocity, and installation conditions where applied.
        4) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2. Air-Handling Unit Factory Assembly:

    a. Furnish and install smoke detectors inside air-handling units to comply with governing building codes.
    b. Install smoke detectors in accordance with smoke detector manufacturer's written installation instructions.

        1) Sampling tubes shall extend the full width of airstream.
        2) Sampling tubes greater than 36 inches long shall be supported on both ends.

    c. Install smoke detectors within air-handling units in a location that is easily accessible for inspection, repair, and replacement of smoke detector, and in a location that does not hinder access to other internal components.

3. Air-Handling Unit Factory Testing: Functionally test smoke detectors to ensure proper operation in accordance with smoke detector manufacturer's written instructions.
4. Air-Handling Unit Factory Installation of Addressable Smoke Detectors Furnished by Building Fire-Alarm System Supplier:

a. Where addressable duct smoke detectors are indicated to be installed within air-handling unit casing, air-handling unit manufacturer shall install duct smoke detector components supplied by building fire-alarm system supplier.
b. Mount duct smoke detector sampling housing on exterior of air-handling unit casing. Locate on accessible side and coordinate with installers before installation.
c. Seal air-handling unit casing penetrations.
d. Install duct smoke detector components in accordance with written instructions furnished by supplier.

1) Sampling tubes shall extend the full width of airstream.
2) Sampling tubes greater than 36 inches long shall be supported on both ends.

e. Photograph installation and transmit photos to fire-alarm system Installer before air-handling unit shipment to ensure proper installation. Fire-alarm system Installer shall review photos and provide written acceptance of installation to air-handling unit manufacturer before air-handling unit shipment.

1) Document date of photos and approval for record purposes.
2) Make corrective measures required by fire-alarm system Installer as required for acceptance.

f. Coordinate work schedule of air-handling unit manufacturer and fire-alarm system supplier to meet requirements of Project schedule.

Y. Hardware:

1. Screws:

a. For Galvanized-Steel Materials: Self-tapping, hex-head, zinc-plate steel or 300 series stainless steel screws with a neoprene gasket encapsulated by a zinc-plate steel or 300 series stainless steel washer.
b. For Aluminum and Stainless Steel Materials: Self-tapping, hex-head, 300 series stainless steel screws with a neoprene gasket encapsulated by a 300 series stainless steel washer.
c. Provide protective covers on exposed screws to prevent personnel injury.

2. Bolts, Nuts, and Washers:

a. For Joining Galvanized and Painted Carbon-Steel Materials: Hex-head, high-strength, galvanized steel or 300 series stainless steel.
b. For Joining Aluminum and Stainless Steel Materials: Hex-head, high-strength, 300 series stainless steel.
c. Use washers and lock washers at each bolted connection.
d. Select bolt size and spacing sufficient for load and application.

Z. Welding:

1. Welding Filler Metals: Comply with AWS welding codes for welding materials appropriate for thickness and chemical analysis of material being welded.

a. Use welding materials with corrosion properties equal to material being welded.

2. Use welders that are certified to weld at least [**twice**]the thickness of the material to be welded. Certification shall be within six months of work being performed.
3. Welds shall be continuous, full-penetration welds unless otherwise indicated. Intermittent welds, stitch welds and tack welds are permitted only in specific applications indicated.
4. Use welders and welding procedures complying with the following:

a. Piping Systems: Section IX of the ASME Boiler and Pressure Vessel Code and Section V of ASME B31.1.
b. Structural Aluminum: AWS D1.2/D1.2M.
c. Structural Carbon Steel: AWS D1.1/D1.1M.
d. Structural Stainless Steel: AWS D1.6/D1.6M.
e. Sheetmetal: AWS D9.1/D9.1M.

AA. Painting:

1. General:

a. Painted OEM components do not require additional coating other than touch-up to damaged areas. Match the touchup coating to surrounding undamaged surfaces.
b. Finish miscellaneous surfaces to match continuous surfaces.
c. Protect mill galvanized surfaces that are exposed to view, such as raw steel cuts and damage by welding, with multiple coats of matching galvanized paint.
d. Protect mill galvanized surfaces that are concealed, such as raw steel cuts and damage by welding, with multiple coats of zinc-rich paint or matching galvanized paint.
e. Touch up or entirely repaint surface finishes, damaged during shipment and installation, to the original condition, using original materials and methods.

2. Preparation:

a. Submit proposed manufacturer's written preparation and application instructions for information.
b. If paint manufacturer's recommended preparation requirements differ from those indicated, use the more stringent requirements.
c. Structural carbon steel to be painted shall be deburred, ground smooth, cleaned, and blasted in accordance with SSPC-SP 6/NACE No. 3 or SSPC-SP 10/NACE No. 5.
d. Before applying a primer and a finish coat, remove oil and grease from surfaces to be coated using clean rags soaked in thinner in accordance with SSPC-SP 1.
e. Treat surfaces to be painted to ensure that paint adheres.

3. Primer:

a. Rust-inhibiting type, with a minimum dry film thickness of 1 mil(s) per coat.
b. Apply at least two coats of primer to unfinished carbon-steel surfaces and at least one coat of primer to other surfaces.
c. Use primer that is compatible with substrate and finish coat.

4. Finish Coat:

    a. Finish coat painting system shall be textured polyester.
    b. Use dry film thickness recommended by paint manufacturer for each coat. Total dry film thickness of all finish coats not less than 3 mils.
    c. Painted Surfaces Minimum Properties:

        1) Salt Spray ASTM B117: 5 percent salt solution fog at 95 deg F for 2000 hours with no deterioration.
        2) Adhesion, ASTM D3359: When the coating is cut into 0.0625-inch squares and 3M No. 600 tape is suddenly removed, there is no loss of adhesion.
        3) Acid Resistance ASTM D3260: 15-minute exposure to 10 percent hydrochloric acid at room temperature with no effect.
        4) Alkali Resistance ASTM D1647: 15-minute exposure to 10 percent sodium hydroxide at room temperature with no effect.
        5) Humidity Resistance ASTM D2247: 850-hour exposure to 100 deg F and at least 95 percent relative humidity with no effect.
        6) Pencil Hardness ASTM D3363: A hardness of 1H.

    d. Finish coat color shall be selected by Architect and not be limited to manufacturer's standard offering.

        1) Submit a written request for color selection and indicate in the request the date color selection must be returned without impacting schedule.

5. Application: Paint the following surfaces with primer and finish coat indicated:

    a. Unfinished carbon-steel surfaces.
    b. Exposed mill galvanized-steel surfaces of air-handling unit casing exterior.

BB. Cleanliness Requirements:

1. General:

    a. Provide equipment that has been manufactured, shipped, stored, and installed maintaining highest degree of cleanliness possible.
    b. Owner Cleanliness Inspection: Air-handling unit(s) cleanliness is subject to Owner cleanliness inspection before packaging for shipment.

2. During Manufacturing:

    a. Clean materials to be free of mill grease, oxidation, dirt, dust, and other impurities before manufacturing and assembly.
    b. Protect casing materials from contamination during manufacturing and assembly.
    c. Use sealing materials that do not outgas.
    d. Provide OEM components and equipment from their respective manufacturers free of grease, oxidation, and dirt. Store OEM components and equipment indoors. Cover and protect OEM components and equipment to maintain cleanliness. Follow OEM instructions for equipment storage.

3. After Manufacturing:

    a. Before shipment, after unit is completely assembled, clean unit inside and out.

        1) Vacuum entire inside to remove dirt, dust, and debris using HEPA-filtered vacuum equipment.
        2) Purge hard to reach surfaces with dry, oil-free, compressed or bottled nitrogen.
        3) Wipe down all surfaces, inside and out, with a residue-free cleaning agent.

    b. Protect unit to maintain cleanliness.

4. Shipping:

    a. Protect interior and exterior of air-handling unit from exposure to weather dirt, dust, and debris during shipment and rigging.
    b. Cover openings with puncture-resistant durable coverings to ensure that cleanliness is maintained inside unit while providing an air- and watertight seal.

5. On-Site Storage:

    a. If air-handling unit is to be stored before installation, Installer shall work closely with air-handling unit manufacturer for air-handling unit manufacturer to provide adequate protection at the factory to ensure that cleanliness for both unit interior and unit exterior is maintained. This protection shall remain in place until unit startup is performed.
    b. For extended periods of storage, provide a means to rotate fan and motor assemblies on a periodic basis (as recommended in writing by manufacturer) without compromising unit cleanliness.

2.4 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. AHRI 260 (I-P): Air-handling unit sound ratings shall be in accordance with AHRI 260 (I-P), "Sound Rating of Ducted Air Moving and Conditioning Equipment."
2. AHRI 410: Air-handling unit coils shall be rated in accordance with AHRI 410 and shall be listed by AHRI.

B. AMCA Compliance:

1. AMCA 201: Air-handling unit manufacturer shall evaluate fan's performance within the air-handling unit in accordance with AMCA 201, "Fans and Systems" and account for conditions within the air-handling unit that could be detrimental to fan's performance by adjusting the fan performance indicated on Drawings.
2. AMCA 205 Certification: Air-handling unit fan's fan efficiency grade (FEG) shall be rated in accordance with AMCA 205, "Energy Efficiency Classifications for Fans" and shall bear the AMCA-certified fan efficiency grade seal.

3. AMCA 210 Certification: Air-handling unit fan's air performance shall be rated in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating" and shall bear the AMCA-certified air ratings seal.
4. AMCA 300: Air-handling unit fan's sound performance shall be rated in accordance with AMCA 300, "Reverberant Room Method for Sound Testing of Fans."
5. AMCA 301 Certification: Air-handling unit fans sound performance shall be rated in accordance with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data" and shall bear the AMCA-certified sound ratings seal.
6. AMCA 500-D: Air-handling unit damper's performance shall be rated in accordance with AMCA 500-D, "Laboratory Methods of Testing Dampers for Rating" and shall bear the AMCA-certified air ratings seal.

C. NFPA Compliance:

1. NFPA 70: Electrical components, devices, and accessories shall be listed and labeled by a qualified testing agency, and marked for intended location and application.
2. NFPA 90A: Design, fabrication, and installation of air-handling units and components shall comply with NFPA 90A.

D. UL Compliance:

1. UL 1598 Certification: Air-handling unit UVGI shall be NRTL listed and labeled in accordance with UL 1598, "Luminaires."
2. UL 1995 Certification: Where indicated, air-handling unit components shall be NRTL listed and labeled in accordance with UL 1995, "Standard for Safety Heating and Cooling Equipment."

2.5 SOURCE QUALITY CONTROL - INDEPENDENT LABORATORY TESTING

A. General:

1. Project-specific testing by an independent laboratory is not required if air-handling unit manufacturer has written independent laboratory test results of past tests performed on same casing construction proposed for use on this Project.
2. If Project-specific testing is required, testing shall be performed in ample time to include test reports with submittals and before manufacturing of air-handling units. Include sufficient lead time for unit delivery, installation, and testing required by construction schedule.

B. Casing Structural Deflection Test:

1. Include service of an independent testing laboratory to verify casing structural deflection requirements indicated.

a. In lieu of independent laboratory testing, manufacturer may perform factory deflection testing of proposed construction to prove compliance if witnessed by Architect and Owner. Manufacturer shall bear cost of labor and travel expenses to witness testing.

2. Test casing construction to performance criteria indicated.
3. Test casing construction proposed for use on Project. Include, at a minimum, particulars such as metal materials and thickness, internal support and reinforcing, and insulation material and thickness.
4. Test largest full-size casing panel proposed for use on Project.
5. Test proposed construction of walls, floor, and roof. Include a separate test for each unique casing construction proposed.
6. Submit test reports for each test to show compliance with performance indicated.

2.6 SOURCE QUALITY CONTROL - AIR-HANDLING UNIT FACTORY TESTS

A. Witness of Testing: Allow Architect, Commissioning Agent, Construction Manager and Owner access to place where air-handling units are being tested for witness testing.

1. Submit written notification at least 30 days in advance of testing.
2. Schedule testing at mutually agreeable dates and times.

B. Witness Testing Travel Expenses:

1. Include in bid the cost of travel expenses to witness factory testing. Total cost for travel expenses shall be clearly indicated separately in bid.
2. Expenses shall include roundtrip coach class airfare, out-of-town hotel accommodations, out-of-town meals (breakfast, lunch, and dinner), out-of-town ground transportation and parking, and all associated taxes and fees.
3. Exclude other incidental expenses not indicated.
4. Include travel expenses for two representative(s).

C. Casing Leakage Test:

1. Perform a leak test for each assembled air-handling unit.
2. Follow testing procedures in accordance with ASHRAE 111.
3. Perform leak test before shipping first air-handling unit.
4. Test results shall indicate that units comply with leakage requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
5. Prepare test reports in accordance with ASHRAE 111.
6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

D. Casing Structural Deflection Test:

1. Perform a structural deflection test for each assembled air-handling unit.
2. Pressurize and load air-handling units to the performance criteria indicated for structural deflection. Test air-handling unit walls and roofs.

3. Test results shall indicate that units comply with deflection requirements indicated. Make changes to noncompliant air-handling units and retest until units comply with requirements.
4. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

E. Functional Run Test:

1. Run test each unit before shipment.
2. Test and balance fans to comply with vibration requirements indicated.
3. Energize each electrical device to ensure it is operational.

    a. Take meter readings for volts, amperes, and kVAr on each phase leg of each motor.
    b. Take meter readings for volts, amperes, and kVAr on each single-phase power connection to field power.

4. Exercise each damper to ensure proper operation.
5. Exercise each access door to ensure proper fit.
6. Exercise each valve to ensure proper operation.
7. Submit a written report for each unit tested. Written report shall include, at a minimum, full name of each person witnessing test, detailed list of each unit component tested, condition observed, and corrective action required. Each line item shall have full name of the person doing the checkout and date and time the checkout was performed.

F. Hydronic Piping Systems Testing: Pressure test factory-assembled piping systems with compressed air or water at a pressure to comply with governing codes and ASME B31.9, but not less than design pressure indicated.

1. Test results shall indicate that piping systems are without leaks. Make changes to noncompliant piping systems and retest until units comply with requirements.
2. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single air-handling unit, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

2.7 SOURCE QUALITY CONTROL - OEM COMPONENT FACTORY TESTS

A. Coil Testing:

1. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.
2. Coils to display a tag with inspector's identification as proof of testing.

B. Fan Vibration Testing:

1. Perform a fan vibration test for each fan.
2. Energize each fan after final assembly and perform a vibration analysis with fan operating at design speed.
3. Three vibration measurements shall be taken for each bearing in the vertical, and axial directions. Vibration measurements shall be recorded and consist of vibration amplitude verses frequency.
4. Fan bearing measurement points shall be marked or scribed on bearings for permanent record.
5. Test results shall indicate units comply with vibration requirements indicated. Make changes to noncompliant fans and retest until fans comply with requirements.
6. Submit test reports indicating test location, documentation of test equipment used, test procedures, test results, test date and time, and full names of personnel performing tests and witnesses. If multiple tests are required to achieve compliance for a single fan, report shall include test date and time, test results, and full names of personnel performing tests and witnesses of each test with a detailed description and photographs of interim corrective measures made before each retest.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine air handling units before installation. Reject units with physical damage, and air-handling unit components that are wet, moisture damaged, or mold damaged.

B. Equipment Mounting: Install air-handling units at locations indicated on Drawings. Unless, otherwise indicated on Drawings, install air-handling units on concrete equipment bases.
1. Install air-handling units on curbs following air-handling unit manufacturer's written procedures.

a. Install gaskets before setting air-handling units on curbs.
b. Secure air-handling units to curbs using stainless steel fasteners.
c. Install curb and fasten to structure.
d. Coordinate curb requirements, attachment, and location before installation.

C. Roof Openings:

1. Provide exact size and location of roof openings to trade installing structural framing and roof structure.
2. Supervise framing of openings to ensure coordinated installation with air-handling units.

D. Seismic Control: Comply with requirements for seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

E. Equipment Clearances and Access:

1. Arrange installation of air-handling units to provide access space around air-handling units for service and maintenance and for removal and replacement of internal components.
2. Provide clearance and access required by governing codes and NFPA 70.
3. At a minimum, comply with requirements indicated on Drawings and air-handling unit manufacturer's written instructions.

3.2 PROTECTION DURING CONSTRUCTION

A. Exterior Covers: Cover air-handling units during construction with sealed covers to protect air-handling unit casing and externally mounted components from physical damage, dirt, dust and debris, paint splatter, and any other construction materials.

1. Minor physical damage, as determined by Owner, shall be repaired by air-handling unit factory service personnel to factory-finished condition.
2. Replace air-handling units with damage that in any way compromises the performance indicated.

B. Internal Access: Keep access doors locked to maximum extent possible and restrict access to only authorized personnel.

1. Open access doors only during periods authorized work inside air-handling units is required.
2. Coordinate and monitor work inside air-handling units on a shift basis. Lock access doors once work is complete or at the end of each shift.
3. Immediately report unauthorized access and any observed damage to Owner.

3.3 DUCT CONNECTIONS

A. Connect ducts and plenums to air-handling unit connections. Comply with requirements in Section 233113 "Metal Ducts."

B. Connect ducts and plenums to air-handling unit connections with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

C. Provide duct transitions required to make field connections to air-handling units.

D. Arrange ducts and plenums to provide unobstructed access to inside of air-handling units.

3.4 PIPING CONNECTIONS

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

B. Where installing piping adjacent to air-handling unit, provide unobstructed access to inside of air-handling units for service and maintenance.

C. Drain Pan Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping."

1. Make connections to air-handling unit connections with unions.
2. Extend drain piping from each air-handling unit connection to nearest equipment or floor drain and arrange piping to maintain clear service aisle paths free of potential tripping hazards.
3. Construct traps near air-handling unit connections to seal airflow from escaping within air-handling unit. Locate traps in a serviceable location that is away from access doors.
4. Install threaded cleanouts at changes in direction.
5. Secure drain piping to structure.

D. Chilled-and Hot-Water Coil Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Comply with requirements indicated on Drawings.
2. Make connections to coils with a flange.
3. Connect to each coil inlet with shutoff valve, test plug, pressure gauge and thermometer.
4. Connect to each coil outlet with balancing valve, test plug, pressure gauge, thermometer and shutoff valve.
5. Connect each coil drain connection with a drain valve, which is full size of drain connection.
6. Connect each coil vent connection with automatic vent, which is full size of vent connection.

3.5 ELECTRICAL CONNECTIONS

A. Install field power to each air-handling unit electrical power connection. Coordinate with air-handling unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 STARTUP SERVICE

A. Engage an air-handling unit factory-authorized service representative to perform startup service.

   1. Complete installation and startup checks in accordance with manufacturer's written instructions.
   2. Verify that shipping, blocking, and bracing are removed.
   3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, controls, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
   4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
   6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
   7. Comb coil fins for parallel orientation.
   8. Verify that proper thermal-overload protection is installed for electric heaters.
   9. Install new, clean filters.
   10. Verify that automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

   1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
   2. Measure and record motor electrical values for voltage and amperage.
   3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Before turning equipment over to Owner for use, adjust air-handling unit components that require further adjustment for proper operation. Consult air-handling unit manufacturer for instruction.

D. 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.

E. Seasonal Adjustments: Make seasonal visits during warranty period to inspect and review operation of equipment. Make necessary adjustments for components observed to require adjustments for proper operation. Prepare and submit a report to Owner documenting each visit, observations, and any adjustments made.

3.9 CLEANING

A. Cleaning Schedule: After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems, and after completing startup service, and immediately before Owner use, clean air-handling units to remove foreign material and construction dirt and dust.

B. Unit Interior: Clean air-handling units internally to factory clean condition. Remove foreign material and construction debris, dirt, and dust.

1. Vacuum clean with HEPA-filtered vacuum and then wipe down with cleaning solution.
2. Clean casing floors, roofs, wall surfaces, access doors, and panels.
3. Clean all internal components, such as, coils, dampers, filter frames, fans, and motors.
4. Clean light fixtures and control devices.

C. Unit Exterior: Clean external surfaces of air-handling units to factory clean condition. Remove foreign material and construction debris, dirt and dust. Vacuum clean with HEPA-filtered vacuum and then wipe down all surfaces with cleaning solution.

D. Cleaning Materials: Use cleaning materials and products recommended in writing by air-handling unit manufacturer.

E. Acceptance: Following unit cleaning submit a written request for review and Owner acceptance. Acceptance for cleaning of air-handling units must pass a white glove test.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. After field piping connections are complete, test hydronic coils and connections for leaks.
2. Field-Assembly Supervision: Instruct Installer and supervise field installation of air-handling unit(s) shipped in multiple pieces for field assembly.

3. Roof-Mounted Field-Installation Supervision: Instruct Installer and supervise field installation of roof-mounted air-handling unit(s).
4. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Field Casing Leakage Test:

1. Perform leak testing of air-handling units that include field assembly of multiple sections. Air-handling units that are shipped and installed as a single piece do not require field testing.
2. Leak test air-handling unit(s) of each unique size and arrangement randomly selected by Owner.
3. Follow procedures complying with ASHRAE 111.
4. Assembled air-handling units shall satisfy leakage criteria indicated. Modify air-handling units that fail to satisfy criteria and retest. For every air-handling unit that fails test, another air-handling unit shall be tested until all air-handling units tested pass leakage criteria on first attempt.
5. Submit a test report for each test indicating test equipment, procedures, results, date and time, and full name of personnel performing tests and witnesses.
6. Test report shall be in accordance with ASHRAE 111.
7. Witness Testing:

    a. Provide written notification at least 30 business days in advance of testing.
    b. Testing shall be conducted in presence of testing and balancing agent.
    c. Other parties such as Architect, Commissioning Agent, and Owner shall be invited to witness testing with attendance being optional.

D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 OPERATION DURING CONSTRUCTION

A. Operation of air-handling units for temporary cooling, heating, and ventilation is not allowed without Owner authorization.

1. Submit written request for Owner approval by signature with detailed description of operating procedures to be followed including, but not limited to, the following:

    a. Description of construction activities while units are operating.
    b. Operation:

        1) Beginning and ending calendar dates.
        2) List each day during week.
        3) List start and stop time and hours for each day.

c. Startup procedures and shut-down procedures.
d. Provisions for routine monitoring of unit operation.
e. Provisions to prevent and protect against damage to equipment due to adverse operation such as, low temperature, high temperature, over pressure, fire, smoke, electrical over- and undervoltage and current and electrical fault.
f. Provisions and safeguards for filtration to keep inside of units from getting dirty.
g. Record keeping.

2. If approved by Owner, units used for temporary cooling, heating, and ventilation during and before interior finish work is complete shall include an unconditional complete unit labor and parts warranty to extend at least two years after the warranty indicated expires.
3. Interior and exterior of air-handling units shall be cleaned to a factory-cleaned condition and clean condition must be accepted by Owner.

B. Filtration during Temporary Use:

1. Protect air-handling system ducts (exhaust air, outdoor air, and return air) with temporary filters installed and supported to prevent filter media from collapse and bypass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 13 in accordance with ASHRAE 52.2.
2. Protect air-handling units with open inlets that are not ducted with temporary filters installed and supported to prevent filter media from collapse and by-pass of unfiltered air. Temporary media shall be installed at each inlet and shall have a published filtration efficiency of MERV 13 in accordance with ASHRAE 52.2.
3. Do not operate air-handling units until both temporary and scheduled permanent air-handling unit particulate filters are in place. Temporary filters must be installed upstream of permanent filters while units are operating.
4. Replace temporary and permanent filters used during construction when dirty. After end of temporary use, replace permanent filters with new, clean filters before beginning testing, adjusting and balancing.

C. Comply with SMACNA 008, "IAQ Guidelines for Occupied Buildings under Construction," for procedures to protect HVAC system.

3.12 DEMONSTRATION

A. Engage air-handling unit manufacturer employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

B. Training shall include, but not be limited to, procedures and schedules related to performance, safety, startup and shut down, troubleshooting, servicing, preventive maintenance, and how to obtain replacement parts.

1. Access Doors: Adjustment, gasket removal and replacement, handle removal and replacement, and spare parts.
2. Access Panels: Removal and replacement, adjustment, gasket removal and replacement, and spare parts.
3. Coils: Cleaning, combing fins, draining, venting, removal, and replacement.

4. Controls: Calibration, cleaning, operation, service, removal and replacement, and spare parts.
5. Damper Assemblies: Cleaning, operation, service, removal and replacement, and spare parts.
6. Drain Pans: Cleaning, removal, and replacement.
7. Duct Silencers: Cleaning, removal, and replacement.
8. Electric Heaters: Cleaning, operation, service, removal and replacement, and spare parts.
9. Heat Wheels: Cleaning, operation, service, removal and replacement, and spare parts.
10. Fan and Motor Assemblies: Cleaning, operation, removal and replacement, service, and spare parts.
11. Filters: Operation, removal and replacement, frame gasket removal and replacement, clip removal and replacement, and spare parts.
12. Fixed Plate heat Exchangers: Cleaning, removal, and replacement.
13. Humidifiers: Cleaning, operation, service, removal and replacement, and spare parts.
14. UV-C Lamp Systems: Cleaning, operation, service, removal and replacement, and spare parts.
15. Lights, Receptacles and Switches: Cleaning, operation, service, removal and replacement, and spare parts.

C. Instructor:

1. Instructor shall be factory trained and certified by air-handling unit manufacturer with current training on equipment installed.
2. Instructor's credentials shall be submitted for review by Architect, Commissioning Agent, or Owner before scheduling training.
3. Instructor(s) job responsibility shall be Owner training.
4. Instructor(s) shall have not less than three years of training experience with air-handling unit manufacturer and past training experience on at least three projects of comparable size and complexity.

D. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for a one-hour lunch period and 15-minute break after every two hours of training.
5. Perform not less than eight hours of training.

E. Location: Owner to provide a suitable on-site location to host classroom training.

F. Training Attendees: Assume three people.

G. Training Attendance Records: For record purposes, document training attendees at start of each new training session. Record date, time, brief description of training covered during the session, attendee's name, signature, phone number, and e-mail address. Submit scanned copy of sign-in sheet to Owner for each training session.

H. Training Format: Individual training modules to include classroom training followed by hands-on field demonstration and training.

I. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

J. Training Video Recording: Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

K. Written Acceptance: Obtain Architect, Commissioning Agent or Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION P - 23 73 43.19

SECTION P - 23 74 16.11

PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS (RTU)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, small-capacity, rooftop air-conditioning units (RTU).

2. This equipment specification is a performance-based specification that establishes minimum requirements and expectations for final design and construction by the Design-Builder. The capacities of the equipment shall be verified by the final design as described in Section 00 20 00 Scope of Work. Before release of equipment procurement orders, the final equipment selections, specifications, drawings, and manufacturer's project-specific data sheets shall be submitted to the Owner for review and approval. Proposed equipment shall conform to the requirements of this Section unless otherwise approved by the Owner.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of RTU.

B. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.

1. Include plans, elevations, sections, and mounting and attachment 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. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Restraint Details: Wind- and seismic-detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates for RTUs, accessories, and components, from manufacturer.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

E. Source quality-control reports.

F. System startup reports.

G. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of packaged, small-capacity, rooftop air-conditioning unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 20 years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. UL Compliance: Comply with UL 1995.

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.

1. Design RTU supports to comply with wind and seismic performance requirements.

F. Wind-Restraint Performance:

1. Basic Wind Speed: 120 mph.
2. Building Classification Category: II.
3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

G. Seismic Performance: RTUs, accessories, and components to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.0.
3. Component Amplification Factor: 2.5
4. Component Response Modification Factor: 6.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to RTU schedule for equipment capacities.

2.3 PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carrier
2. Daikin
3. Trane
4. York

B. Unit Casings:

1. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
2. Double-Wall Construction:

a. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

b. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
c. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
d. Casing Insulation:

1) Materials: Injected polyurethane foam insulation.
2) Casing Panel R-Value: Minimum R-8.
3) Insulation Thickness: 2 inches.
4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

3. Airstream Surfaces: Surfaces in contact with airstream to comply with requirements in ASHRAE 62.1.
4. Static-Pressure Classifications:

a. For Unit Sections Upstream of Fans: Minus 4-inch wg.
b. For Unit Sections Downstream and Including Fans: 8-inch wg.

5. Panels and Doors:

a. Panels:

1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement to allow panels to be opened against air-pressure differential.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

b. Access Doors:

1) 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.
2) Gasket: Neoprene, applied around entire perimeters of panel frames.
3) Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

c. Locations and Applications:

1) Fan Section: Inspection and access panels.
2) Access Section: Doors.
3) Coil Section: Inspection and access panels.
4) Damper Section: Inspection and access panels.
5) Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

6. Condensate Drain Pans:

    a. Location: Each type of cooling coil.
    b. Construction:

        1) Single-wall, galvanized-steel or noncorrosive polymer or stainless steel sheet.

    c. Drain Connection:

        1) Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
        2) Minimum Connection Size: NPS 1.

    d. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
    e. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    f. Width: Entire width of water producing device.
    g. Depth: A minimum of 2 inches deep.
    h. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
    i. Units with stacked coils must have an intermediate drain pan to collect condensate from top coil.

C. Fans, Drives, And Motors:

1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
2. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

    a. Shafts: With field-adjustable alignment.

        1) Turned, ground, and polished hot-rolled steel with keyway.

    b. Shaft Bearings:

        1) Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

    c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

        1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

d. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
e. Mounting: For internal vibration isolation and seismic control. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
f. Shaft Lubrication Lines: Extended to a location outside the casing.
g. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.

1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives to comply with UL 181, Class 1.

3. Drives, Direct: Factory-mounted, direct drive.

4. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated ECM motors.
5. Relief-Air Fan: Backward inclined, shaft mounted on permanently lubricated motor.
6. Motors:

a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
b. 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.
c. Enclosure Type: Open, drip-proof or Totally enclosed, fan cooled.
d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

D. Coils:

1. General Requirements for Coils:

a. Comply with AHRI 410.
b. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
c. Coils to not act as structural component of unit.

2. Supply-Air Refrigerant Coil:

a. Tubes: Copper.
b. Fins:

1) Material: Aluminum.
2) Fin Spacing: Maximum 12 fins per inch.

c. Fin and Tube Joints: Mechanical bond.
d. Headers: Seamless-copper headers with brazed connections.

e. Frames: Galvanized steel.
f. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

1) Working Pressure: Minimum 300 psig.

E. Refrigerant Circuit Components:

1. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.
2. Refrigeration Specialties:

a. Refrigerant: R-32 or R-454B.
b. Expansion valve with replaceable thermostatic element.
c. Refrigerant filter/dryer.
d. Manual-reset high-pressure safety switch.
e. Automatic-reset low-pressure safety switch.
f. Minimum off-time relay.
g. Automatic-reset compressor motor thermal overload.
h. Brass service valves installed in compressor suction and liquid lines.
i. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

F. Air Filtration:
1. Panel Filters:

a. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
b. Filter Unit Class: UL 900.
c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

G. Gas Furnaces:

1. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: Stainless steel.

a. Rated Minimum Turndown Ratio: 30 to 1.
b. Fuel: Natural gas.
c. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
d. Gas Control Valve: Modulating.
e. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

4. Heat-Exchanger and Drain Pan: Stainless steel.

5. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve with vertical extension.
6. Safety Controls:

    a. Gas Manifold: Safety switches and controls complying with ANSI standards.

H. Dampers:
1. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate must not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg rated in accordance with AMCA 500D).
2. Barometric relief dampers.
3. Electronic Damper Operators:

    a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
    b. Electronic damper position indicator to have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
    c. Operator Motors:

        1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
        2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
        3) 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.

    d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
    e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf.
    f. Size dampers for running torque calculated as follows:
        1) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
        2) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
        3) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
        4) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

    g. Coupling: V-bolt and V-shaped, toothed cradle.
    h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
k. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
l. Temperature Rating: Minus 22 to plus 122 deg F.
m. Run Time: 12 seconds open, 5 seconds closed.

I. Electrical Power Connections:

1. RTU to have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

J. Controls:

1. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC "

K. Roof Curbs:
1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1) Materials: ASTM C1071, Type I or II.
2) Thickness: 2 inches.

b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

1) Liner Adhesive: Comply with ASTM C916, Type I.
2) Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
3) Liner materials applied in this location to have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

2. Curb Dimensions: Height of 14 inches.

L. Accessories:
1. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet is to be energized even if the unit main disconnect is open.
2. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
3. Remote potentiometer to adjust minimum economizer damper position.
4. Factory- or field-installed, demand-controlled ventilation.

5. Safeties:

    a. Smoke detector.
    b. Condensate overflow switch.
    c. Phase-loss protection.
    d. High pressure control.
    e. Gas furnace airflow-proving switch.

6. Coil guards of painted, galvanized-steel wire.
7. Outdoor-air intake weather hood.

2.4 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

2.5 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

B. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

3.2 PIPING CONNECTIONS

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

B. Where installing piping adjacent to RTU, allow space for service and maintenance.

C. Connect piping to unit mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.3 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.4 ELECTRICAL CONNECTIONS

A. Connect electrical wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate is to be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
   2. Locate nameplate where easily visible.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

E. Prepare test and inspection reports.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION P - 23 74 16.11

SECTION 07 50 00

ROOFING AND FLASHING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide complete design, engineering, documentation, permitting support, demolition coordination, substrate repair, fabrication, installation, testing, inspection, training, closeout, and warranty for a complete low-slope membrane roofing and sheet metal flashing system.

B. Roof membrane shall be EPDM or TPO. Do not mix field membrane types within a continuous roof area.

C. Work includes membrane, base flashing, full insulation replacement, cover board, air/vapor control, thermal barrier where required, tapered drainage system, drains and overflows coordination, walkways, expansion joints, equipment curbs and penetrations, fascia, copings, gravel stops, counterflashings, reglets, cleats, drip edges, sealants, blocking coordination, and all accessories required for a complete warrantable system.

D. Provide temporary protection and sequencing required to keep the building dry, safe, and operational throughout the Work.

1.2 DESIGN-BUILD RESPONSIBILITY

A. The Contractor is the single point of responsibility for roofing and flashing design and construction, including subcontractors, manufacturers, fabricators, installers, and delegated design professionals.

B. Retain qualified design professionals licensed where the Project is located when engineering or professional services are required. Prepare and seal calculations and documents as required by governing authorities.

C. Field verify roof geometry, substrate and deck type, structural limitations, existing assembly, moisture, drainage, penetrations, curbs, edges, adjacent construction, interior conditions, and environmental exposure. Do not rely solely on concept or record documents.

D. Select a complete tested assembly and coordinate every component for compatibility, fire classification, wind uplift, condensation control, drainage, durability, and warranty eligibility.

E. Resolve conflicts by meeting the most stringent applicable requirement unless the Owner approves a written deviation. Owner review does not transfer design responsibility.

1.3 PERFORMANCE REQUIREMENTS

Criterion	Minimum Requirement
Watertightness	Continuous roofing and flashing system without leakage, open seams, blow-off, flutter, billowing, buckling, corrosion, or loss of attachment under design conditions.
Membrane options	EPDM complying with ASTM D4637 or TPO complying with ASTM D6878. Provide one manufacturer-standard, tested, listed, and warrantable system.
Fire classification	Class A roof-covering assembly under ASTM E108 or classification required by adopted code, whichever is more stringent.
Wind uplift	Engineer field, perimeter, corner, edge, flashing, fastener, adhesive, and termination conditions for project-specific code pressures and required insurance criteria. Provide tested assembly ratings not less than calculated demands.
Thermal performance	Provide the greater of Owner criteria, adopted energy code, and final thermal/condensation analysis. Use multiple insulation layers with staggered joints.
Drainage	Provide positive drainage. Use minimum nominal 1/4 inch per foot tapered insulation where required. Coordinate primary and secondary drainage, crickets, saddles, sumps, and overflow paths.
Air/vapor control	Develop a continuous air and vapor control approach appropriate to climate, interior design conditions, deck, construction moisture, and adjacent enclosure systems.
Edge metal	Engineer and test low-slope roof edge securement to ANSI/SPRI ES-1 and project pressures. Coordinate cleats, joints, corners, terminations, movement, and compatible separation.
Service access	Provide slip-resistant walkways from roof access points to serviceable equipment and at concentrated maintenance locations.
Warranty	Provide manufacturer and Design-Builder warranties specified herein. Warranty wind limit shall not be less than the accepted design basis and not less than 72mph.

1.4 REFERENCE REQUIREMENTS

A. Comply with adopted building, energy, fire, mechanical, and plumbing codes; authority having jurisdiction requirements; project insurer criteria where applicable; and selected manufacturer requirements.

B. Use current applicable editions adopted for the Project of ASTM C1289, ASTM D4637, ASTM D6878, ASTM E96, ASTM E108, ASTM E2178, ANSI/SPRI ES-1, FM roof-system and roof-edge criteria, NRCA Roofing Manual, SMACNA Architectural Sheet Metal Manual, applicable UL/FM listings, ASTM B209, and AAMA 2605.

C. Where a legacy baseline identified in this Section is less stringent than current code, tested assembly, or manufacturer warranty requirements, comply with the more stringent requirement.

1.5 SUBMITTALS

A. Design Criteria Report: Identify codes, climate and environmental criteria, membrane selection, substrate findings, fire classification, wind pressures by roof zone, assembly ratings, thermal criteria, condensation analysis, drainage calculations, attachment concept, edge-metal design, and warranty basis.

B. Existing Conditions Report: Document roof composition, deck and substrate condition, moisture findings, elevations, drainage, penetrations, curbs, flashings, blocking, wall transitions, and repairs. Include photographs and test locations.

C. Delegated-Design Calculations: Submit signed and sealed calculations where required for wind uplift, attachment, edge securement, drainage, and related engineered components.

D. Design Drawings: Provide coordinated roof plans, roof zones, slopes, elevations, drainage paths, tapered insulation layout and thicknesses, attachment patterns, equipment and penetrations, walkways, expansion joints, phasing, and keyed details for every condition.

E. Product and System Data: Identify each component and furnish manufacturer confirmation that the complete assembly, substrate, flashings, edge metal, sealants, and accessories are compatible, listed as required, and eligible for the specified warranty.

F. Samples: Submit membrane and flashing samples, insulation and cover-board samples, walkway sample, metal finish samples, termination bars, representative fasteners, and an edge-metal profile sample.

G. Submit installer authorization, qualifications, sample warranties, installation instructions, inspection and test plan, protection plan, and a separately identified schedule of exceptions or substitutions.

1.6 QUALITY ASSURANCE

A. Manufacturer shall have at least 20 years of documented experience producing the selected membrane-system type.

B. Roofing installer shall have at least 10 years of documented experience with comparable systems, be approved by the selected manufacturer, and be eligible to obtain the specified warranty. Sheet metal installer shall have comparable relevant experience.

C. Use one roofing manufacturer as the source of, or warrantor accepting, membrane, insulation, adhesives, fasteners, flashings, and accessories included in the total-system warranty.

D. Conduct a preinstallation conference with the Design-Builder, roofing and sheet-metal installers, roofing manufacturer, affected trades, Owner, and Owner representative. Review substrate acceptance, calculations, details, drainage, weather, phasing, protection, inspections, testing, and warranty requirements.

E. Provide representative first-work installations or mockups for roof edge, curb, penetration, drain, and wall-transition conditions when required by the Owner. Accepted work establishes the minimum workmanship standard.

1.7 PRODUCT HANDLING AND FIELD CONDITIONS

A. Deliver materials in original labeled containers with seals intact. Store elevated, dry, ventilated, protected from weather, sunlight, damage, and temperatures outside manufacturer limits. Do not overload or permanently deflect the deck.

B. Do not install over wet, frozen, contaminated, unstable, or unaccepted substrates, during precipitation, or outside manufacturer weather limitations. Remove only areas that can be made watertight the same workday.

C. Provide secure temporary tie-ins, drainage, monitoring, and protection of occupied areas, active equipment, adjacent finishes, drains, and air intakes.

1.8 GUARANTEE AND WARRANTY

A. Manufacturer Warranty: Furnish a 20-year total-system, no-dollar-limit watertight warranty in the Owner's name covering labor and materials to correct leaks attributable to warranted components. Include membrane, insulation, cover board, attachment, adhesives, flashings, and manufacturer-approved edge metal where available.

B. Contractor and Installer Warranty: Furnish a signed 3-year warranty covering defects in materials and workmanship not fully covered by the manufacturer warranty, beginning at Substantial Completion.

C. Factory-Applied Metal Finish Warranty: Furnish a 20-year warranty against premature finish failure.

D. Disclose all warranty exclusions, wind limits, maintenance obligations, consequential-damage limitations, and monetary limits with the proposal. Warranty wind coverage shall equal or exceed the accepted design basis.

PART 2 - PRODUCTS

2.01 MEMBRANE ROOFING - GENERAL

A. Provide either a complete EPDM system or a complete TPO system as permitted by Owner criteria. System selection shall be based on existing conditions.

B. Acceptable legacy basis-of-design manufacturers include Carlisle SynTec and Elevate/Firestone, GAF, Versico, GenFlex. Equivalent systems are permitted when the Design-Builder demonstrates equal or superior compliance with the performance and warranty criteria.

C. Do not combine products that are incompatible or that reduce listings or warranty coverage. Obtain written manufacturer acceptance of substrates, treated wood interfaces, sealants, adhesives, vapor-control materials, walkways, flashings, and metals.

2.02 COMMON ROOF ASSEMBLY REQUIREMENTS

A. Assembly shall include, as required by final design: membrane; membrane flashing; cover board; flat and tapered insulation; thermal barrier; air/vapor retarder; substrate board or deck treatment; attachment or adhesive systems; walkways; drains and termination accessories.

B. Select fully adhered or mechanically attached construction based on deck condition, wind pressures, fire listing, environmental conditions, phasing, service expectations, and warranty. Mechanically attached systems shall include engineered in-seam or manufacturer-standard securement and enhanced perimeter/corner attachment.

C. Provide increased attachment, enhanced adhesive patterns, or higher-rated assemblies in perimeter, corner, edge, and other high-pressure zones as required by calculations and listings.

2.03 EPDM MEMBRANE SYSTEM

A. EPDM membrane: ASTM D4637, minimum nominal 90 mil, black unless another standard color is accepted. Reinforced, unreinforced, backed, or unbacked sheets are permitted only when part of the accepted tested assembly and suitable for the attachment method.

B. EPDM membrane flashing: Minimum 90 mil, cured or uncured as appropriate to manufacturer details. Provide preformed corners, pipe seals, T-joint covers, and accessories where available.

C. EPDM seams: Manufacturer-standard taped or heat-welded seam technology where offered and included in the selected system. Provide primers, seam tape, lap sealant, water cutoff mastic, bonding adhesive, termination bars, battens, plates, and fasteners required by the accepted details.

D. Allow sheets to relax and install without wrinkles, bridging, fishmouths, voids, or distortion. Provide uniform laps and stagger end laps.

2.04 TPO MEMBRANE SYSTEM

A. TPO membrane: ASTM D6878, scrim reinforced, minimum nominal 90 mil, factory-produced in the largest practical sheets. Color selected by Owner from manufacturer standard colors.

B. TPO membrane flashing: Minimum 90 mil, matching and compatible with field membrane. Provide prefabricated corners, boots, and accessories where available.

C. TPO seams: Heat welded using manufacturer-approved equipment, settings, overlap widths, cleaners, primers, tapes, adhesives, and edge treatments. Adhesive-only field seams are not permitted unless part of an accepted manufacturer system and detail.

D. Install without wrinkles, bridging, fishmouths, voids, stretching, or contamination. Provide uniform laps and stagger end laps.

2.05 THERMAL, AIR, AND VAPOR CONTROL MATERIALS

A. Polyisocyanurate insulation: ASTM C1289, Type II where suitable, 20 psi minimum compressive strength, square edges, current code-compliant labeled thermal resistance, and facers compatible with adjacent materials. Install in at least two layers where total thickness permits.

B. Tapered insulation: Factory-tapered system configured for positive drainage, minimum nominal 1/4 inch per foot where required.

C. Cover board: Manufacturer-approved board selected for fire classification, impact resistance, substrate compatibility, durability, and warranty. 5/8” minimum thickness, gypsum based type. HD polyiso is not acceptable.

D. Thermal barrier: Provide where required by code, listing, deck construction, or final system design. Attachment shall satisfy the tested assembly and calculated pressures.

E. Air/vapor retarder: Provide an adhered sheet or other manufacturer-approved system when required by enclosure and condensation analysis. Seal laps, terminations, penetrations, and transitions continuously to adjacent air-barrier systems.

2.06 SHEET METAL FLASHING AND TRIM

A. Provide fascia, gravel stops, copings, counterflashings, reglets, flashing receivers, drip edges, expansion-joint covers, penetration flashings, cleats, and related trim required by final design.

B. Roof edge system: Manufacturer-approved aluminum system engineered and tested to ANSI/SPRI ES-1, suitable for project pressures, and included in the roofing warranty where available.

C. Aluminum sheet: ASTM B209, alloy and temper suitable for fabrication and finish. Minimum 0.040 inch for manufacturer-engineered fascia systems and minimum 0.050 inch for custom exposed trim and copings unless engineering requires greater thickness.

D. Extruded aluminum: ASTM B221, alloy suitable for use, minimum 0.080 inch at primary legs unless a tested proprietary system requires otherwise.

E. Stainless steel: Type 304 where used for reglets, receivers, or flashings; thickness based on engineering and fabrication, not less than legacy 0.0156 inch for receivers or 0.0187 inch for general sheet unless a tested system requires otherwise.

F. Finish: AAMA 2605 fluoropolymer coating or Class I anodic finish as selected by Owner. Coordinate color with adjacent existing construction. Provide matching or compatible fasteners and accessories.

G. Fabrication: Shop form true, straight, and free of distortion. Hem exposed edges, provide drips, prefabricate corners, conceal fasteners, and accommodate movement without oil-canning, buckling, open joints, or loss of watertightness. Final joint spacing shall comply with engineering, SMACNA, profile geometry, and manufacturer requirements.

H. Provide non-curing butyl concealed sealant, compatible exterior sealant at exposed joints, separation layers at treated wood and dissimilar or corrosive substrates, and manufacturer-approved adhesives, clips, straps, anchors, rivets, and fasteners.

2.07 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Provide manufacturer-compatible penetration boots, corners, expansion-joint assemblies, termination bars, pitch pockets only where no better detail is feasible, cleaners, primers, sealants, drain components, and all incidental accessories.

B. Walkways: Nonporous, slip-resistant, membrane-compatible pads or rolls at service routes, access points, and equipment. Use manufacturer-standard sizes and attachment.

C. Wood nailers and blocking: Coordinate species and treatment, dimensions, elevation, anchorage, isolation, and moisture content. Replace deteriorated, improperly anchored, or undersized components as part of the complete Work.

PART 3 - EXECUTION

3.01 EXAMINATION AND ACCEPTANCE

A. Verify dimensions, elevations, deck support and attachment, drainage, openings, curbs, penetrations, nailers, reglets, wall interfaces, substrates, and adjacent air-barrier conditions before fabrication or installation.

B. Test concrete and existing roof materials for moisture using methods accepted by the selected roofing manufacturer. Identify trapped moisture and remove or remediate affected materials. Do not proceed until substrates are accepted in writing as required by the quality plan.

C. Confirm hazardous-material investigation responsibilities before disturbing existing roofing, flashing, mastics, insulation, sealants, or coatings.

D. Document concealed or differing conditions and incorporate the accepted resolution into final design documents.

3.02 DEMOLITION, PREPARATION, AND TEMPORARY PROTECTION

A. Coordinate removals with structural, mechanical, electrical, and other work. Protect occupied spaces, active equipment, air intakes, drains, and adjacent finishes from water, dust, fumes, and debris.

B. Remove only areas that can be permanently or temporarily made watertight before the end of the work period. Provide secure tie-ins and positive temporary drainage.

C. Clean substrates and remove projections and incompatible materials. Repair deck, curbs, blocking, and adjacent construction as required to receive the accepted system.

D. Prevent roofing materials and debris from entering drains. Remove temporary drain plugs when work stops or precipitation is forecast.

3.03 THERMAL, AIR/VAPOR, AND INSULATION INSTALLATION

A. Install thermal barrier and air/vapor components to accepted design and manufacturer instructions. Seal transitions continuously at edges, walls, openings, penetrations, curbs, and blocking.

B. Install insulation in straight courses, tightly butted, with gaps not exceeding 1/4 inch. Fill unacceptable gaps with compatible insulation. Stagger joints between layers at least 6 inches and avoid coincident joints.

C. Adhere or mechanically attach each layer and cover board to achieve tested and calculated uplift resistance. Document adhesive coverage, fastener types, spacing, and enhanced wind zones.

D. Install tapered insulation to the final slope plan. Trim and sump at drains without restricting flow. Verify drainage before membrane installation and correct back-slope or ponding conditions.

E. Do not leave insulation or vulnerable materials exposed overnight. Remove wet or damaged materials unless the manufacturer provides written acceptance of another remedy.

3.04 MEMBRANE INSTALLATION - GENERAL

A. Install the selected EPDM or TPO system according to accepted design documents, tested assembly requirements, and current manufacturer instructions.

B. Start representative membrane installation in the presence of manufacturer technical personnel when required by the inspection plan or warranty program.

C. Provide enhanced securement at perimeters, corners, changes in plane, curbs, penetrations, and terminations. Orient laps to shed water where practical.

D. Flash walls, curbs, penetrations, drains, expansion joints, and terminations using manufacturer-approved and warrantable details. Provide base flashing height required by code and manufacturer, not less than 8 inches where practicable; submit project-specific details where constraints prevent this height.

E. At drains, install membrane over compatible water-cutoff material and secure using clamping ring or accepted proprietary assembly. Recess drains and perform water-flow observation before closeout.

3.05 EPDM MEMBRANE PLACEMENT AND SPLICING

A. Allow EPDM sheets to relax for the manufacturer-required period. Align accurately and maintain uniform side and end laps.

B. For mechanically attached systems, secure membrane using manufacturer-standard in-seam plates, battens, or other tested attachment. For adhered systems, apply bonding adhesive at the required rate and fully roll or broom membrane into place.

C. Prepare, prime, tape or weld, and roll seams using the selected manufacturer system. Seal exposed cut edges and terminations where required. Repair tears, voids, wrinkles, and deficient seams.

D. Adhere flashing and mechanically terminate where required. Use cured or uncured flashing appropriate to corners, penetrations, and transitions.

3.06 TPO MEMBRANE PLACEMENT AND HOT-AIR WELDING

A. For mechanically attached systems, provide tested in-seam attachment and secure edge and termination conditions. For adhered systems, apply adhesive at required coverage and fully embed and roll membrane.

B. Heat weld seams to manufacturer width and settings. Perform trial welds at the start of each work period and when conditions or equipment settings change. Probe every seam after cooling and repair defects.

C. Maintain daily records of test welds, equipment settings, ambient conditions, seam probing, repairs, and manufacturer observations.

D. Install prefabricated or field-fabricated flashings using accepted heat-welded details and compatible sealants at terminations.

3.07 GENERAL REQUIREMENTS FOR METAL FLASHING

A. Install edge metal, fascia, gravel stops, copings, counterflashings, reglets, receivers, and trim to final engineered details, SMACNA guidance, and manufacturer instructions. Use concealed fastening except where specifically accepted.

B. Set cleats and anchor bars in continuous compatible sealant where required. Use manufacturer splice components and prefabricated corners to maintain continuous air and water seals.

C. Provide movement joints at intervals established by final design and at changes in direction and terminations. Do not fasten across movement joints. Form seams in the direction of drainage.

D. Isolate aluminum and stainless steel from treated wood, wet cementitious materials, incompatible substrates, and dissimilar metals. Arrange interfaces to drain and avoid galvanic action.

E. Make exposed lines and planes true, crisp, and free of objectionable waves, warp, buckle, tool marks, sealant smears, and irregular fasteners.

3.08 TESTING AND INSPECTION

A. Implement the approved inspection and test plan. Inspect substrate acceptance, daily dry-in, attachment, adhesive coverage, membrane seams, flashings, edge securement, drainage, and protection.

B. Provide manufacturer technical representative visits at initial/substrate work, representative membrane and flashing installation, and completion, plus visits required for warranty issuance. Submit written reports and correct deficiencies.

C. Perform EPDM seam quality checks and TPO trial welds and seam probing appropriate to the selected system. Provide electronic leak detection, flood testing, or other integrity testing when required by the Design-Build Agreement or accepted testing plan.

D. Do not conceal work requiring inspection. Reopen concealed work at Design-Builder expense where necessary to verify compliance.

3.09 CLEANUP AND PROTECTION

A. Clean roofing, drainage components, sheet metal, and adjacent surfaces. Remove sharp debris, temporary materials, markings, oils, excess sealant, and construction residue. Repair damaged membrane and finishes.

B. Submit record roof plan and details, tapered insulation plan, photographs, test records, inspection reports, product data, maintenance instructions, warranty documents, installer certifications, attic stock, and Owner training record.

C. Train Owner personnel regarding access, walkway use, inspection frequency, drainage maintenance, repair protocols, future penetrations, and warranty notification requirements.

D. Protect completed work through Substantial Completion using durable temporary protection wherever construction traffic or overhead work continues.

END OF SECTION 07 50 00

SECTION 23 05 00

COMMON WORK RESULTS FOR MECHANICAL

PART 1 – GENERAL

A. SUMMARY

A. This Section covers general work described in the drawings and all other specifications under Division 23.

B. Provide a complete working mechanical installation with all equipment called for in proper operating condition. Documents do not undertake to show or list every item to be provided. When an item not shown or listed is necessary for proper operation of equipment, provide the item at no increase in contract cost.

C. The terms "provide", "furnish", and "install" as used in Division 23 Contract Documents shall have the following meanings:

   a. "Provide" shall mean "furnish and install".

   b. "Furnish" does not include installation.

   c. "Install" does not include furnishing.

D. Include all mechanical connections to equipment provided by others. Refer to architectural, structural, and other trade drawings, specifications, and final approved shop drawings for connection requirements.

E. Any recommended deviation from the project specifications shall be submitted in writing with appropriate justifications (e.g., potential value engineering item). The cost estimates shall be based on the specified equipment.

B. RELATED WORK

A. The General Conditions, Supplementary Conditions, and applicable portions of Divisions 1, 23, and other Divisions referenced herein apply to the work of this Section as if printed herein.

B. This Specification is applicable to all mechanical scope of work.

C. In the event of conflict between this common Specification and any other detailed specifications, the provision of this common Specification shall govern.

C. SUBMITTALS

A. Approval of submittal documents shall extend only to determining the conformity with the general features of the contract drawings and specifications.

B. Forward all submittals in related groups. Individual or incomplete submittals are not acceptable.

C. Provide a certificate of compliance with project specifications. Identify any exceptions taken from the requirements with appropriate justification. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.

D. Identify each submittal item by reference to Specification Section paragraph in which the item is specified or drawing and detail number.

E. Organize submittals in same sequence as they appear in specification sections, articles or paragraphs.

F. Shop drawings shall show physical arrangement, construction details and finishes including:

   a. Scaled and dimensioned drawings
   b. All required maintenance access and NEC required clearances
   c. Catalog cuts and published material with scaled drawings

G. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project with all optional items clearly identified as included or excluded. Clearly identify external wiring connections.

H. Prepare submittal material binders in accordance with the following:

   a. Insert all literature in standard 3-ring binders for 8-1/2” by 11” pages with individual tabs. Do not staple literature on different products together.
   b. Number all binders on the outside of the cover and indicate the Specification Section.
   c. Provide an index with binder. This index shall follow the same sequence as the specifications.

I. Provide the electronic file of all the submittals consistent with the binder sets.

J. Submittal literature, drawings, and wiring diagrams shall be specifically applicable to this project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item.

K. Submittals shall include, but not be limited to, those items listed in individual sections:

a. Identify the proposed equipment by the same designation as shown on the plans.
b. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, safety data sheets, accessories, and all other data required to completely describe equipment and to indicate complete compliance with specifications and drawings.
c. Include with complete submittals above, complete, large scale, dimensioned shop drawings, certified by manufacturer, of all major equipment and other equipment as directed by the Engineer.
d. Submittals which are not complete and/or not clearly identified as to which items are applicable will be returned without review.

L. Resubmittals will be reviewed for compliance with comments made on the original submittal only. All modifications shall be clearly marked with a resubmittal number and dated.

M. Provide factory and field testing reports and certificates.

N. Operating & maintenance instructions and manuals:

a. Subsequent to final completions and testing operations, instructed by authorized representatives in operation, adjustment, and maintenance of mechanical plant.
b. Submit three (3) copies of certificate, signed by the company's representatives, attesting to their having been instructed.
c. Before personnel assume operation of systems, submit three (3) sets of operating and maintenance manuals. Bind data in vinyl covered loose-leaf binders with title index tabs identifying items therein to include:

1) Outdoor, Custom Air-Handling Units

2) Packaged Rooftop Air-Conditioning Units

3) Direct Digital Control System for HVAC

d. Each operating and maintenance manual shall include the following:

1) Copies of all shop drawings.
2) Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type of model shall be designated.
3) Wiring diagrams.
4) Additional information, diagrams or explanations as designated under the respective equipment or systems specification section.

e. Phone numbers and addresses of local parts suppliers and service companies.
f. Provide one (1) full size print of Record Drawing(s).

g. Provide electronic file of all documents.

O. Submit as-built drawings showing actual constructed conditions, in accordance with the provisions of Section 01 78 39 – Requirements for Contractor Turnover Packages.

D. QUALITY ASSURANCE

A. Provide materials listed and labeled by Underwriters Laboratories (UL). At the Engineer's discretion, other Nationally Recognized Testing Laboratory (NRTL) acceptable to Authority Having Jurisdiction (AHJ) may be considered.

B. Materials and systems:

a. Materials and equipment shall be provided that are standard products of Manufacturers regularly engaged in the production of such products, which are of a similar material, design, and workmanship. Standard products shall have been in satisfactory commercial use for minimum two (2) years.
b. Provide new and ship to jobsite in original manufacturer's containers or bundles.

C. All work, materials, and equipment shall comply with requirements of the applicable standards listed below. Nothing in the drawings or specifications shall be construed to permit work not conforming to applicable laws, ordinances, rules, regulations. It is not the intent of drawings or specifications to repeat requirements of codes except where necessary for completeness or clarity.

a. Americans with Disabilities Act (ADA)
b. American National Standards Institute (ANSI)
c. American Society for Testing and Materials (ASTM)
d. National Electrical Code (NEC)
e. National Electrical Manufacturer's Association (NEMA)
f. National Fire Protection Association (NFPA)
g. International Mechanical Code (IMC)
h. International Building Code (IBC)
i. International Fuel Gas Code (IFGC)
j. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE)
k. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
l. Air Movement and Control Association (AMCA)
m. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
n. Underwriters Laboratories, Inc. (UL)

D. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirement shall govern.

E. WARRANTY

A. Each piece of equipment shall be guaranteed to perform as specified free of defects in workmanship and material for a minimum period of one (1) year after its final acceptance.

B. Standard manufacturer's warranty shall be provided. Multiple warranties for individual components will not be acceptable.

C. At the end of the one-year warranty period, the supplier shall make a maintenance and/or service agreement available to the facility personnel.

F. DELIVERY, STORAGE AND HANDLING

A. Contractors shall refer to specific project requirements for material and products to be delivered to the project site.

B. Deliver products, materials, and equipment marked with product name, model number, and any other information needed for identification. Inspect items for shipping damage and reject damaged goods.

C. Store products, materials, and equipment as required by the manufacturer to prevent damage and degradation. Store on skids or pallets above the grade. Provide a secure, fenced, and well-lit area for outdoor storage.

D. Carefully handle, transport, and position items to prevent damage during construction.

E. Replace lost or damaged materials and equipment with new at no increase in contract cost.

G. DRAWINGS

A. For purposes of clarity, legibility, drawings are essentially diagrammatic.

B. Exact routing of piping, ductwork, and associated mechanical accessories shall be governed by structural conditions, obstructions, equipment requirements, and existing conditions. The Engineer reserves the right, at no increase in cost, to make any reasonable change in locations and routing of mechanical components exposed above ceilings, within mechanical spaces, and/or on walls to maintain orderly installation, improve coordination with other trades, and enhance system functionality. The Contractor shall verify the Engineer's requirements in this regard prior to fabrication and installation of the work.

C. Dimensions, locations of doors, partitions, ceilings, equipment, and similar architectural and structural features shall be taken from the architectural and structural drawings. Mechanical components, including piping, ductwork, air terminals, diffusers, grilles, registers, and equipment connections, shall be located

and coordinated with these features and installed at the approximate locations shown on the mechanical drawings unless otherwise directed.

H. COORDINATION WITH OTHER WORK

A. Site and utilities:

a. Visit and examine the site conditions prior to submitting a proposal. Site staging and storage requirements and access to all areas shall be reflected in the proposal.
b. Determine utility connection requirements and include in the base bid all costs for utility service.
c. Include all costs associated with temporary service, temporary routing of service or any other requirements of a temporary nature associated with utility service.

B. Continuity of service:

a. No service shall be interrupted or changed without written permission from the Owner. Obtain written permission before any work can be commenced.
b. When interruption of services is required, all impacted personnel shall be notified and shall agree upon a time.

C. Demolition:

a. Perform demolition work as required and as approved by the Engineer to accommodate the new Work. Coordinate demolition activities with all affected trades and maintain operation of existing systems not designated for removal.
b. Unless otherwise indicated, remove from the premises and legally dispose of all materials, piping, ductwork, equipment, supports, insulation, and appurtenances removed as part of the demolition work.
c. Remove abandoned mechanical equipment, ductwork, piping, valves, hangers, supports, specialties, insulation, control devices, and associated components that are not required for the completed installation.
d. Disconnect, remove, cap, plug, or blind mechanical services serving equipment scheduled for removal. Maintain the integrity and operation of existing systems that are to remain.
e. Remove mechanical systems, equipment, piping, ductwork, and associated components located within walls, floors, ceilings, and other construction scheduled for demolition or renovation.
f. Where existing piping or ductwork is removed, provide permanent closures, caps, blanks, and seals as required to maintain system operation, pressure integrity, fire ratings, and weather resistance.
g. Protect mechanical systems, equipment, and building surfaces designated to remain. Repair or replace components damaged during demolition operations at no additional cost to the Owner.
h. Where materials or equipment are designated for reuse or turnover to the Owner, carefully remove, protect, store, transport, and reinstall as indicated.

Maintain the condition of such materials and equipment equal to that existing prior to commencement of Work. Replace damaged items at no additional cost to the Owner. Deliver items designated for Owner turnover to the location identified by the Owner.

i. Accomplish demolition work in a neat and workmanlike manner to minimize disruption, interference, noise, dust, or inconvenience to the Owner, occupants, and other contractors.

j. Coordinate removal and reconnection of electrical power, control wiring, disconnect switches, and associated electrical work serving mechanical equipment with Division 26. Electrical work shall be performed under Division 26 requirements unless specifically noted otherwise.

D. Trade coordination:

a. Coordinate all "tight" conditions involving work specified in this Division in advance of installation. If necessary, and before work proceeds in these areas, prepare supplementary drawings for review, showing all work in "tight" areas and additional work necessary to overcome these conditions.

b. Differences or disputes concerning coordination, interference, or extent of work between trades shall be decided by the General Contractor (GC). GC's decision, if consistent with the Contract Documents requirements, shall be final.

c. Coordinate power and control wiring requirements for mechanical equipment specified in Division 23.

d. Where conflict exists between rough-in shown on drawings and that shown or required by equipment to be installed, obtain written clarification from the Architect and provide rough-in as directed.

e. Provide templates, information, and instructions to other trades to properly locate holes and openings to be cut or provided for mechanical work.

E. Equipment rough-in:

a. Rough-in locations shown on mechanical drawings for equipment furnished by Owner and for equipment specified in other Divisions are approximate only. Obtain exact rough-in locations from following sources:

1) From final approved shop drawings for Contractor-furnished and installed equipment.
2) From Architect for Owner-furnished, Contractor-installed equipment.

b. When the installation requires openings and access through existing construction, coordinate this work with the GC and provide the necessary requirements.

c. Verify mechanical characteristics of equipment before starting rough-in. Where conflict exists between equipment and rough-in shown on Drawings, obtain clarification from the Engineer and provide as directed.

F. Concrete work:

a. Provide cast-in-place concrete as detailed in the Contract Documents unless otherwise noted.
b. All floor mounted mechanical equipment shall be set on concrete housekeeping pads which are a minimum 4” in height. Concrete housekeeping pad size, height, and load capacity shall be based on the final approved equipment submittal.

G. Painting:

a. All equipment shall be furnished with factory applied finish coats, as specified.
b. If factory finish is damaged in shipment or during construction, refinish equipment to satisfaction of the Engineer.
c. Furnish one can of touch-up paint for each factory finish that matches final finished surface of the product.

PART 2 - PRODUCTS

A. MATERIALS FURNISHED

A. For similar equipment, provide equipment of one manufacturer, alike in appearance and function.

B. For equipment specified by manufacturer's number, include all accessories, controls, etc., listed in catalogue as standard with equipment. Furnish optional or additional accessories as required for proper operation or as specified.

C. Where no specific make of material or equipment is mentioned, propose product of reputable manufacturer conforming to requirements of system and other applicable specification sections for the Engineer’s approval.

D. Equipment and materials damaged during transportation, installation, or operation is considered as totally damaged. Replace with new.

E. Provide an authorized representative to constantly supervise work specified in this Division; check all materials prior to installation for conformance with drawings, specifications and approved shop drawings.

F. All enclosures provided shall comply with the following NEMA enclosure types:

a. NEMA 1 – for use in dry indoor locations
b. NEMA 12 – for use in indoor locations subject to dust, dirt, and light water splashing
c. NEMA 3R – for use in wet indoor locations
d. NEMA 4X – for use in outdoor locations and indoor corrosive environment. Only 316 grade stainless steel is acceptable.

B. PRODUCT SUBSTITUTION

A. Acceptable manufacturers are listed in each mechanical specification. The cost estimates shall be based on the specified equipment.

B. If an alternate product is proposed, a request for deviation from standard specifications shall be submitted in writing with appropriate justification (e.g., lower total cost of ownership (TCO), improved reliability, and improved safety). Written approval is required before work may proceed.

C. BUILDING STANDARDS

A. When Authority Having Jurisdiction (AHJ) has specific building standards for materials, products, methods and types of construction, these standards supersede those of other evaluation or listing agencies referenced in the Specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Manufacturer's directions:

a. Installation procedures are required to be in accordance with the manufacturer's recommendations. Installation shall not proceed until printed copies of the recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

B. Workmanship:

a. Perform work in accordance with accepted standards of workmanship as recognized by the Mechanical Contractors Association of America (MCAA).

C. Equipment:

a. Accurately set and level with supports neatly placed and properly fastened as shown and specified. Provide means of bringing in and installing equipment into position inside building.

D. Penetrations:

a. Pack space between pipe sleeves in walls with non-combustible materials.
b. Make penetrations through floors water-tight with non-hardening sealant even though concealed within wall or furred space.
c. Make penetrations through any damp-proofed/water-proofed surfaces damp-proof/waterproof by appropriate means to maintain integrity of system penetrated.

d. Seal around penetrations with UL listed fireproofing material to maintain integrity of fire rating.
e. Unused sleeves and slots shall be identified for future use by permanently anchored brass nameplates identifying size and purpose of the covered slot.

E. Seismic requirement:

a. The seismic design of all systems and components shall comply with the project-specific design requirements indicated in the Contract Documents. The Importance Factor shall match that of the facility.
b. Obtain the services of a registered structural engineer specialist in the design of seismic restraint members and methods of anchorage to the building structure. Submit complete calculations and shop drawing for review to the Engineer.

F. Hangers, supports, anchors and chases:

a. Support and/or anchor all mechanical equipment, piping, ductwork, and controls systems to resist gravity and seismic forces in accordance with conditions stated in the Contract Documents.
b. Support materials shall be galvanized steel or 316 grade stainless steel as appropriate for the application.
c. Provide hangers, anchors, and supports for piping and ductwork as specified.
d. Provide concrete inserts for attachment of hangers; subject to structural engineer's review.
e. Provide anchors for floor and wall mounted equipment.
f. Provide supports for wall mounted equipment.
g. Do not support equipment or fixtures from metal roof decking.

G. Equipment protection:

a. In occupied areas, mechanical rooms and areas requiring normal maintenance access, all equipment must be guarded to protect personnel from injury.
b. Provide minimum 1/2-inch thick insulation or protective padding, securely adhered to exposed lower edges and corners of suspended mechanical components, including piping, ductwork, pipe supports, trapeze hangers, valves, strainers, and mechanical accessories located less than 7 feet above floors, platforms, catwalks, or other accessible walking surfaces. Install protection wherever personnel could come into contact with these components during normal operation or maintenance activities.
c. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

H. Hazardous locations:

a. Mechanical equipment installed in hazardous locations shall comply with NEC requirements and all applicable local codes.

3.2. RELATED WORK

A. Excavating and backfilling:

A. Provide as required for installation of mechanical work in accordance with requirements of other applicable project specifications.

B. Provide all necessary shoring, sheeting and pumping.

C. In any asphalt or concrete paved areas, backfill only to subgrade level.

B. Concrete:

A. In accordance with the requirements of Division 3.

C. Sleeves, chases and concrete inserts:

A. Provide sleeves, chases, concrete inserts, anchor bolts, etc., before concrete is poured.

B. Sleeves, chases are prohibited in structural members, except where shown or approved in writing.

D. Cutting and repairing:

A. Do all cutting, repairing, including structural reinforcing, necessary for work specified in this Division. Do not proceed without written approval of the Engineer.

B. Repair damages and restore area to the original condition as deemed by the Engineer.

E. Housekeeping and cleanup:

A. Periodically as work progresses and/or as directed by General Contractor, remove waste materials from building and leave area of work broom clean.

B. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from the site. Clean all equipment, such as air handling units, rooftop units, etc., that have been installed or accessed as part of this Contract, of all dirt, dust and other foreign objects.

F. Painting and finishing:

A. Specific job requirements shall be referred to in accordance with Manufacturer's instruction for all the finishing work. All marred or damaged factory painted finishes shall be repaired with materials and procedures to match original factory finish.

3.3. INSPECTIONS

A. Obtain and pay for all inspections required by AHJ and deliver approved inspection certificates to Owner.

3.4. TESTING AND ADJUSTING

A. Refer to 23 05 93 – Testing, Adjusting, and Balancing for HVAC.

B. Notify Engineer and Inspectors required to observe the test when the test is ready to be performed at least two weeks prior to testing date.

C. Furnish all labor and test equipment required for testing specified in this Division.

D. All testing equipment and testing results shall be certified. Certifications shall include identification of portion of system tested, date, time, test criteria and name and title of the person signing test certification documents.

E. Maintain copies of certified tests, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in the TOP.

F. Perform testing and balancing by certified TAB agency.

G. Balance air systems.

H. Balance hydronic systems.

I. Submit final TAB report.

J. Rebalance as required following commissioning.

K. Submit test reports and certificates for review.

3.5. STARTUP AND COMMISSIONING

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This shall include Owner- Furnished, Contractor-Installed equipment as well.

B. Follow manufacturer’s pre-startup checklist, start-up, trouble shooting and adjustment procedures. Contractor shall provide qualified personnel knowledgeable in start-up and check-out of types of systems and equipment on project.

C. Coordinate and support start-up services by manufacturer’s representative where specified or where Contractor does not have qualified personnel. Coordinate start-up with all trades.

D. Provide support for the Commissioning Agent as specified in this Division and the Commissioning Plan.

3.6. EQUIPMENT IDENTIFICATION

A. Identify all major equipment.
B. Provide labels for:
   a. AHUs.
   b. RTUs.
   c. Control panels.
C. Lettering shall match Owner standards.
D. Refer to Section 23 05 53 – Identification for HVAC Piping and Equipment for detailed equipment identification requirements.

3.7. TURNOVER PACKAGE (TOP) DOCUMENTATION:

A. Refer to Turnover Procedures of the Contract Documents.

B. Upon completion of work, but before final acceptance of system, submit to Engineer for approval three hard copies and one electronic file of the TOP documentation. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit all three hard copies to Owner.

C. Prepare and submit complete set of record drawings in accordance with Contract Documents.

3.8. CLEANING AND PAINTING

A. Properly prepare work to be finish painted as specified in other applicable project specifications.

B. Refinish damaged work supplied with final finish to satisfaction of Engineer.

C. Clean debris from exposed equipment surfaces and mechanical spaces.

D. Replace temporary filters prior to turnover.

E. Leave systems ready for operation.

3.9. TRAINING

A. System training to Owner’s Representatives is of prime importance and shall be provided prior to final acceptance.

END OF SECTION 23 05 00

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Strut support systems - rooftop mounted.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230500 "Common Work Results for HVAC" for pipe guides and anchors.
3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Rooftop-mounted strut support systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for trapeze hangers.

2. Detail fabrication/assembly and design calculations for each type of strut support system, by the manufacturer's technical representative.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washers made of carbon steel.

B. Pipe Hangers and Supports - Stainless Steel:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Pipe/Tube Hangers and Supports - Copper:
   1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 STRUT SUPPORT SYSTEMS - ROOFTOP MOUNTED

A. General Requirements: Shop-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Pipe Stand - Compact:
   1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Hardware: Galvanized steel or polycarbonate.
   4. Accessories: Protection pads.

C. Pipe Stand - Single Base, Single Pipe, Low Profile:
   1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Vertical Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.
   4. Horizontal Member: Adjustable height, galvanized-steel pipe support channels.
   5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger.
   6. Hardware: Galvanized steel.
   7. Accessories: Protection pads.
   8. Height: 12 inches above roof.

D. Pipe Stand - Single Base, Single Pipe, High Profile:
   1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Single vulcanized rubber or molded polypropylene.
   3. Vertical Members: Two, galvanized-steel, continuous-thread 1/2-inch rods.

4. Horizontal Member: One, adjustable height, galvanized-steel pipe support slotted channel or plate.
5. Pipe Supports: Roller, Clevis hanger, or Swivel hanger.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread galvanized-steel rod.
8. Height: 36 inches above roof.

E. Pipe Stand - Multiple Pipe, High Profile:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber.
3. Vertical Members: Two or more, galvanized-steel channels.
4. Horizontal Members: One or more, adjustable height, galvanized-steel pipe support.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: 36 inches above roof.

F. Pipe Stand - Curb-Mounted-Type: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100 psi, ASTM C552, Type II cellular glass with 100 psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125 psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield are to cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield are to cover bottom 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities required for supported loads and building materials where used.
1. Indoor Applications: Zinc-plated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

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

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields are to span an arc of 180 degrees.

    a. Thermal-hanger shield inserts may be used as an option. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
    b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

G. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

H. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

I. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

J. Fastener System Installation:
1. Install mechanical-expansion anchors after concrete is placed and completely cured.
2. Install fasteners in accordance with manufacturer's written instructions.

K. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

L. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

M. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

    a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting" and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use stainless steel pipe hangers and stainless steel or corrosion-resistant attachments for corrosive environment applications.

G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 23 05 29

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.
12. Snubbers.
13. Restraints - rigid type.
14. Restraints - cable type.
15. Restraint accessories.
16. Post-installed concrete anchors.
17. Concrete inserts.

B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals:

1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, and restrained isolation roof-curb rail that is required by this Section or is indicated on Drawings, submit the following:

    a. Seismic and Wind-Load Restraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
    b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
    d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
    e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
    f. Qualified Professional Engineer: All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Seismic- and Wind-Restraint Detail Drawing:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. All delegated design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and

spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Welding certificates.

C. Field quality-control reports.

D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.
4. The following HVAC systems and components are Designated Seismic Systems and require written special certification of seismic qualification by manufacturer:

    a. Custom Packaged DX Rooftop Units.

    b. Packaged DX Rooftop Units

E. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:

    a. Custom Packaged DX Rooftop Units.

    b. Packaged DX Rooftop Units

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic- and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic and wind- load control system.
    1. Seismic and Wind-Load Performance: Equipment to withstand the effects of earthquake motions and high wind events determined in accordance with ASCE/SEI 7-16.

B. Seismic Design Calculations:
    1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.

        a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
        b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
        c. Building Occupancy Category: III.

d. Building Risk Category: II.
e. Building Site Classification: D.

2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
   1) S_{DS} = Spectral Acceleration: 0.20g to 0.25g. Value applies to all components on Project.
   2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
   3) I_p = Component Importance Factor: See Drawing Schedule for each component.
   4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
   5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
   6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" to be taken as zero.
   7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
c. Seismic Relative Displacement D_{pI}: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

   1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.2.
   2) I_e = Structure Importance Factor: 1.0. Value applies to all components on Project.
   3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
   4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
   5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
   6) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
   7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.

8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
10) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a: See Drawings Schedules for each component.

d. Component Fundamental Period T_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
2) g = Gravitational Acceleration : 32.17 fps2.
3) K_p = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated design seismic engineer.

3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
1) S_{DS} = Spectral Acceleration: 0.20g to 0.25g. Value applies to all components on Project.
2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
3) I_p = Component Importance Factor: See Drawing Schedule for each component.
4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from equipment submittal.
5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
6) z = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" to be taken as zero.
7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.

b. Vertical Seismic Design Force: Calculate by Delegated Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
c. Seismic Relative Displacement D_{pl}: Calculate by Delegated Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.

2) I_e = Structure Importance Factor: 1.0. Value applies to all components on Project.
3) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
4) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
5) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
6) h_x = Height of Level x to which Upper Connection point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data;
7) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
8) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
9) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
10) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a: See Drawing Schedule for each component.

4. Calculation Factors, ASCE/SEI 7-05, Ch. 3 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.

   a. Horizontal Seismic Design Force F_p: Calculated by Delegated Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation:
      1) S_{DS} = Spectral Acceleration: <**Insert value**>. Value applies to all components on Project.
      2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
      3) I_p = Component Importance Factor: See Drawing Schedule for each component.
      4) W_p = Component Operating Weight: Obtain by Delegated Design Contractor for each component from component submittal.
      5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
      6) z = Height in Structure of Point of Attachment of Component for Base: Determine by Delegated Design Contractor for each component from Project Drawings. For items at or below the base, "z" to be taken as zero.
      7) h = Average Roof Height of Structure for Base: Determine by Delegated Design Contractor from Project Drawings.

   b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
   c. Seismic Relative Displacement D_p: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) δ_{xA} = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
2) δ_{yA} = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
3) δ_{yB} = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
4) h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
5) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated Design Contractor from Project Drawings and manufacturer's data.
6) Δ_{aA} = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
7) Δ_{aB} = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
8) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a: See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

    a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
    b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
2. Design wind pressure "p" for external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations in accordance with one of the following, as applicable:

    a. PART 1: Low-Rise Buildings.
    b. PART 2: Low-Rise Buildings (Simplified).
    c. PART 3: Buildings with "h" less than 60 feet.
    d. PART 4: Buildings with "h" greater than 60 feet and less than 160 feet.
    e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
    a. Risk Category: II.
    b. h = Mean Roof Height: 18 feet.

c. V = Basic Wind Speed: 120.
d. K_d = Wind Directionality Factor: 0.85.
e. Exposure Category: C.
f. K_{zt} = Topographic Factor: 1.0.
g. K_e = Ground Elevation Factor: 1.0.
h. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): 0.88.
i. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): 0.88.
j. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
k. q_h = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 Section 26.10.1 or other source approved by authorities having jurisdiction.
l. G = Gust-Effect Factor: 0.85.
m. Enclosure Classification: Enclosed.
n. GC_{pi} = Internal Pressure Coefficient: +/-0.18.

4. Design wind pressure "p" for external sidewall-mounted equipment such as louvers are to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" greater than 60 feet.
   d. PART 4: Buildings with "h" less than 160 feet.
   e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
   a. Risk Category: II.
   b. h = Mean Roof Height: 18.
   c. V = Basic Wind Speed: 120.
   d. K_d = Wind Directionality Factor: 0.85.
   e. Exposure Category: C.
   f. K_{zt} = Topographic Factor: 1.0.
   g. K_z = Velocity Pressure Exposure Coefficient: 0.88.
   h. K_h = Velocity Pressure Exposure Coefficient: 0.88.
   i. q_z = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 or ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   j. q_h = Velocity Pressure: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-16 or ASCE/SEI 7-10 Section 26.10.1 or other source approved by authorities having jurisdiction.
   k. G = Gust-Effect Factor: 0.85.
   l. Enclosure Classification: Enclosed.
   m. GC_{pi} = Internal Pressure Coefficient: +/-0.18.

6. Design wind force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

a. I = Importance Factor: 1.0.
b. h = Mean Roof Height: 18.
c. V = Basic Wind Speed: 120.
d. K_d = Wind Directionality Factor: 0.85.
e. Exposure Category: C.
f. K_{zt} = Topographic Factor: 1.0.
g. K_z = Velocity Pressure Exposure Coefficient (Evaluated at Height z): 0.88.
h. K_h = Velocity Pressure Exposure Coefficient (Evaluated at Height h): 0.88.
i. q_z = Velocity Pressure at Height z: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
j. q_h = Velocity Pressure at Roof Height h: Value calculated by delegated wind-load design Contractor using methods detailed in ASCE/SEI 7-05 Section 6.5.10 or other source approved by authorities having jurisdiction.
k. G = Gust-Effect Factor: 0.85.
l. GC_{pi} = Internal Pressure Coefficient: +/-0.18.
m. C_f = Force Coefficient: Value determined by delegated wind-load design Contractor from ASCE/SEI 7-05, Figures 6-21 through 6-23 or other source approved by authorities having jurisdiction.
n. A_f = Projected Area Normal to the Wind: Except where C_f is specified for the actual surface area, value determined by delegated wind-load design Contractor from equipment submittal or manufacturer.

D. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.

E. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:

1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig.

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
    b. Top housing with attachment and leveling bolt, threaded mounting holes and internal leveling device, or elastomeric pad.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
    b. Top plate with threaded mounting holes or elastomeric pad.
    c. Internal leveling bolt that acts as blocking during installation.

2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable or non-adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch-Thick Neoprene:

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.10 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch-Thick Neoprene:

1. Factory-Set Height Guide with Shear Pin: Shear pin to be removable and re-insertable to allow for selection of pipe movement. Guides to be capable of motion to meet location requirements.

2.11 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.12 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.13 SNUBBERS

A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.14 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.15 RESTRAINTS - CABLE TYPE

A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts

designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.16 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.17 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.18 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

B. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.2 INSTALLATION OF VIBRATION-CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators, wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint, and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

H. Ductwork Restraints:

1. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.
4. Select seismic-restraint devices with capacities adequate to carry static and seismic loads.
5. Install cable restraints on ducts that are suspended with vibration isolators.

I. Install seismic- and wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

J. Install seismic- and wind-load-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

K. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

L. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

M. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

N. Mechanical Anchor Bolts:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.4 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform tests and inspections with the assistance of a factory-authorized service representative.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

C. Remove and replace malfunctioning units and retest as specified above.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 23 05 48

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Related Requirements:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
   1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

   1. Products: Subject to compliance with requirements, provide the following:
      a. CertainTeed Corp.; SoftTouch Duct Wrap
      b. Johns Manville; Microlite
      c. Knauf Insulation; Friendly Feel Duct Wrap
      d. Manson Insulation Inc.; Alley Wrap
      e. Owens Corning; SOFTR All-Service Duct Wrap

G. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide the following:
    a. CertainTeed Corp.; Commercial Board
    b. Johns Manville; 800 Series Spin-Glas
    c. Knauf Insulation; Insulation Board
    d. Manson Insulation Inc.; AK Board
    e. Owens Corning; Fiberglass 700 Series

2.3 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H.B. Fuller Company, CP-127.
    b. Eagle Bridges – Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide the following:
    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    b. Eagle Bridges - Marathon Industries; 550.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    d. Mon-Eco Industries, Inc.; 55-50.
    e. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:
    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.

4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets: Reinforced thermoplastic polyolefin (TPO) membrane to comply with ASTM C921, Type 1, unless otherwise indicated.

B. Field-applied jackets shall be similar to and compatible with the existing duct jacket(s) materials for areas where partial duct jacket replacement and/or areas of overlapping materials may occur.

C. Minimum thickness: 45 mil.

D. Suitable for continuous exterior exposure and resistant to:
1. Ultraviolet degradation.
2. Moisture intrusion.
3. Fungal growth.
4. Mechanical damage normally encountered in rooftop service.

E. Self-Adhesive Outdoor Jacket (Asphaltic): 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide available products that may be incorporated into the Work include, but are not limited to, the following:

a. Polyguard Products, Inc.; Alumaguard 60.

2.7 TAPES

A. Provide manufacturer's standard seam tape, edge sealant, adhesives, and accessories required for a complete weatherproof installation.

2.8 SECUREMENTS

A. Aluminum Bands: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
1. Products: Subject to compliance with requirements, provide the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide the following:
        1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.
    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide the following:
        1) GEMCO; Nylon Hangers.
        2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
    b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide the following:
        1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
        2) GEMCO; Peel & Press.
        3) Midwest Fasteners, Inc.; Self Stick.
    b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    d. Adhesive-backed base with a peel-off protective cover.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, provide the following:
   1) AGM Industries, Inc.; RC-150.
   2) GEMCO; R-150.
   3) Midwest Fasteners, Inc.; WA-150.

b. Nelson Stud Welding; Speed Clips.

c. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

5. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) GEMCO.
      2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with the Contract Documents, unless otherwise approved by the engineer of record.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Cut insulation in a manner to avoid compressing insulation.

L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

M. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over-compress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over-compress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where TPO jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.6 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.

8. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air Duct and Plenum Insulation: Glass-fiber blanket, 2 inches thick and 1.0 lb/cu. ft. nominal density.

B. Concealed, Return-Air Duct and Plenum Insulation: Glass-fiber blanket, 2 inches thick and 1.0 lb/cu. ft. nominal density.

C. Concealed, Outdoor-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

D. Exposed, Supply-Air Duct and Plenum Insulation: Glass-fiber blanket, 2 inches thick and 1.0 lb/cu. ft. nominal density.

E. Exposed, Return-Air Duct and Plenum Insulation: Glass-fiber blanket, 2 inches thick and 1.0 lb/cu. ft. nominal density.

F. Exposed, Outdoor-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Concealed, Supply-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

C. Concealed, Return-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

D. Concealed, Outdoor-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

E. Exposed, Supply-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

F. Exposed, Return-Air Duct and Plenum Insulation: Glass-fiber board, 3 inches thick and 3 lb/cu. ft. nominal density.

END OF SECTION 23 07 13

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.

2. Piping specialties
3. Joining materials.
4. Manual gas shutoff valves.
5. Pressure regulators.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Certificates:

1. Welding certificates.

C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Pipe Welding: Qualify procedures and operators in accordance with the ASME Boiler and Pressure Vessel Code.

1.6 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide purging and startup of natural-gas supply in accordance with requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural-gas service without Owner's written permission.

1.7 COORDINATION

A. Coordinate requirements for access panels and doors for valves installed and concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

B. Coordinate requirements for piping identification for natural-gas piping. Comply with requirements in Section 220553 "Identification of Plumbing Piping and Equipment."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with the International Fuel Gas Code.

B. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.
3. Minimum Operating Pressure of Service Meter: 5 psig.

C. Natural-Gas System Pressure within Buildings:
1. Two pressure ranges. Primary pressure is more than 0.5 psig, but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

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. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Component Importance Factor: 1.0.
3. a_p = Component Amplification Factor: See Drawing Schedule for each component.
4. R_p = Component Response Modification Factor: See Drawing Schedule for each component.

2.2 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

B. Corrugated, Stainless Steel Tubing: Comply with ANSI/IAS LC 1/CSA 6.26.
1. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
2. Coating: PE with flame retardant.

a. Surface-Burning Characteristics: As determined by testing identical products in accordance with ASTM E84 by 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.

3. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
4. Striker Plates: Steel, designed to protect tubing from penetrations.
5. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections are to comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
6. Operating-Pressure Rating: 5 psig.

C. Annealed-Temper Copper Tube: Comply with ASTM B837, Type G.

1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
2. Flare Fittings: Comply with ASME B16.26 and SAE J513.

a. Copper fittings with long nuts.
b. Metal-to-metal compression seal without gasket.
c. Dry-seal threads complying with ASME B1.20.3.

D. PE Pipe: ASTM D2513, SDR 11.

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
c. Aboveground Portion: PE transition fitting.
d. Outlet is threaded or flanged or suitable for welded connection.
e. Tracer wire connection.
f. UV shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.

b. Outlet is threaded or flanged or suitable for welded connection.
c. Bridging sleeve over mechanical coupling.
d. Factory-connected anode.
e. Tracer wire connection.
f. UV shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated, stainless steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Seals: Nitrile.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [**40**] [**60**]-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap:

1. Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.5 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dry-seal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves NPS 1-1/4 to NPS 2 having initials "WOG" permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
4. Service Mark: Initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.

7. Ends: Threaded, flared, or socket as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

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. Lee Brass Company.
    b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground, Manual Gas Shutoff Valve Schedule" and "Aboveground, Manual Gas Shutoff Valve Schedule" articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller are to be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.6 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80A.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Maxitrol 325-xALxx with Overpressure Protection Device or comparable product by one of the following:

    a. Actaris.
    b. American Meter Company.
    c. Eclipse Combustion, Inc.
    d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    e. Invensys.

f. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: UV-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
9. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Canadian Meter Company Inc.
b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: NBR.
6. Seal Plug: UV-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Hart Industries International, Inc.
d. Jomar International Ltd.
e. Matco-Norca, Inc.
f. McDonald, A. Y. Mfg. Co.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
h. Wilkins; a Zurn company.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.8 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

B. Label and identify gas piping and pressure outside a multitenant building by tenant.

PART 3 - EXECUTION

3.1 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping in accordance with the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for preventing accidental ignition.

3.2 INSTALLATION OF OUTDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping in accordance with ASTM D2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Copper Tubing with Protective Coating:

1. Apply joint cover kits over tubing to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

F. Install fittings for changes in direction and branch connections.

G. Install pressure gauge upstream and downstream from each service regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

3.3 INSTALLATION OF INDOOR PIPING

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Do not install piping in concealed locations unless sleeved with the sleeve open at both ends.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Where installing piping above accessible ceilings, allow sufficient space for ceiling panel removal.

G. Locate valves for easy access. Do not locate valves within return air plenums.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gauge [**downstream**] [**upstream and downstream**] from each line regulator. Pressure gauges are specified in Section 230500 "Common Work Results for HVAC."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

3.4 INSTALLATION OF VALVES

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless steel tubing, aluminum, or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

F. Do not install valves in return-air plenums.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, and then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for steel piping and copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for corrugated stainless steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of steel piping and copper tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of corrugated stainless steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas-appliance equipment grounding conductor of the circuit powering the appliance in accordance with NFPA 70.

C. Where installing piping adjacent to appliances, allow space for service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

3.8 LABELING AND IDENTIFICATION

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test, inspect, and purge natural gas in accordance with and authorities having jurisdiction.
2. Natural-gas piping will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.11 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping is to be one of the following:

1. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
2. Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints. Coat pipe and fittings with protective coating for copper tubing.
4. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Annealed-temper copper tube with wrought-copper fittings and brazed joints.

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:

1. Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper, tin-lined copper tube with flared joints and fittings.
3. Annealed-temper, copper tube with wrought-copper fittings and brazed joints.
4. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Underground, below building, piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.
3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN OR EQUAL TO 2 PSIG (13.8 kPa)

A. Aboveground, branch piping NPS 1 and smaller is to be one of the following:

1. Corrugated stainless steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
2. Annealed-temper copper tube with wrought-copper fittings and brazed joints.
3. Aluminum tube with flared fittings and joints.
4. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with steel welding fittings and welded joints.
3. Drawn-temper copper tube with wrought-copper fittings and brazed joints.

C. Underground, below building, piping is to be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
4. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground portion of vent pipe and fittings with protective coating for steel piping.

3.14 UNDERGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground:

1. PE valves.
2. NPS 2 (DN 50) and Smaller: Bronze plug valves.

3.15 ABOVEGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter are to be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller are to be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves in branch piping for single appliance are to be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION 23 11 23

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Piping joining materials.
4. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Product data.

B. Delegated Design Submittals:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors, alignment guides, and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

B. Qualification Data: For Installer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K and ASTM B88, Type L.

B. Annealed-Temper Copper Tube: ASTM B88, Type K and ASTM B88, Type L.

C. DWV Copper Tube: ASTM B306, Type DWV.

D. Cast-Copper, Solder-Joint Fittings: ASME B16.18 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

E. Wrought-Copper, Solder-Joint Fittings: ASME B16.22 pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.

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. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.

F. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.

G. Cast-Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 4.

H. Wrought-Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M black steel with plain ends; welded and seamless, Grade B, and schedule number as indicated in Part 3,"Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3, "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3, "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3, "Piping Applications" Article.

E. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B32, lead-free alloys.

B. Flux: ASTM B813, water flushable.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Hart Industries International, Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.

2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig minimum at 180 deg F.
    c. End Connections: Solder-joint copper alloy and threaded ferrous. Solder joints are not to be used on pipe sizes greater than NPS 4.

C. Dielectric Flanges:

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. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

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. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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. Perfection Corporation; a subsidiary of American Meter Company.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Victaulic Company of America.

2. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F1545.
c. Pressure Rating: Minimum 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

1. Type L , drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

1. Schedule 40, Grade B, steel pipe; wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

E. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."

Q. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."

R. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

D. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

B. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.

C. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting and coupling.

F. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 SYSTEM STARTUP

A. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping in accordance with ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve.
5. Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

END OF SECTION 23 21 13

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Requirements:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraint devices and installation.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation

L. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:
   1. Ductwork is to be galvanized steel.
      a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 099113 "Exterior Painting."
   2. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 230713 "Duct Insulation."

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

   1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   2. Outdoor, Supply-Air Ducts: Seal Class A.
   3. Outdoor, Return-Air Ducts: Seal Class C.
   4. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
   5. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
   6. Unconditioned Space, Return-Air Ducts: Seal Class B.
   7. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
   8. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
   9. Conditioned Space, Return-Air Ducts: Seal Class C.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
   a. Supply Ducts with a Pressure Class of 2 Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.

5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

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

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
5. Provide drainage and cleanup for wash-down procedures.

6. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.8 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Roof Top Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 24.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air Handling Units:

a. Pressure Class: Positive 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to Roof top Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A
c. SMACNA Leakage Class for Rectangular: 6
d. SMACNA Leakage Class for Round and Flat Oval: 3.

2. Ducts Connected to Air Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A
c. SMACNA Leakage Class for Rectangular: 6
d. SMACNA Leakage Class for Round and Flat Oval: 3.

3.

D. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Velocity 1000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1000 to 1500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

    c. Velocity 1500 fpm or Higher:

        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct Requirements for All Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

END OF SECTION 23 31 13

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

B.

1. Control dampers.
2. Flange connectors.
3. Turning vanes.
4. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Sustainable Design Submittals:

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Control-damper installations.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 CONTROL DAMPERS

A. General Requirements:

1. Unless otherwise indicated, use parallel-blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed-blade configuration.
2. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.

B. Performance:

1. Leakage:

   a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
   b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
   c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
   d. Class III: Leakage shall not exceed 40 cfm/sq. ft. against 1-inch wg differential static pressure.

2. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm
4. Temperature: Minus 25 to plus 180 deg F
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

C. Construction:

1. Linkage out of airstream.
2. Suitable for horizontal or vertical airflow applications.
3. Frames:

   a. Hat, U, or angle shaped.
   b. 18-gauge- thick galvanized steel.

c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple blade with maximum blade width of 6 inches
b. Parallel blade design.
c. Galvanized steel
d. 16-gauge- thick single skin

5. Blade Edging Seals:

a. Replaceable Closed-cell neoprene
b. Inflatable seal blade edging, or replaceable rubber seals.

6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch diameter; galvanized steel.
8. Blade-Linkage Hardware: Zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of air stream.
9. Bearings:

a. Oil-impregnated bronze
b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

D. Damper Actuator - Electric:

1. Electric - 24 V ac.
2. UL 873, plenum rated.
3. Two position or Fully modulating (See plan)

a. Sufficient motor torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
b. Minimum 90-degree drive rotation.

4. Clockwise or counterclockwise drive rotation as required for application.
5. Environmental Operating Range:

a. Temperature: Minus 40 to plus 130 deg F
b. Humidity: 5 to 95 percent relative humidity noncondensing.

6. Environmental enclosure: NEMA 2.
7. Actuator to be factory mounted and provided with a single-point wiring connection.

2.3 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.4 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Vane Construction:

1. single wall.
2. Single wall for ducts up to 48” wide and double wall for larger dimensions.

2.5 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.6 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G60.
2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Install Control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install flexible connectors to connect ducts to equipment.

I. Install duct test holes where required for testing and balancing purposes.

J. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

A. SUMMARY

A. This Section covers general work described in the drawings and all other specifications under Division 26.

B. Provide a complete working electrical installation with all equipment called for in proper operating condition. Documents do not undertake to show or list every item to be provided. When an item not shown or listed is necessary for proper operation of equipment, provide the item at no increase in contract cost.

C. The terms "provide", "furnish", and "install" as used in Division 26 Contract Documents shall have the following meanings:

a. "Provide" shall mean "furnish and install".

b. "Furnish" does not include installation.

c. "Install" does not include furnishing.

D. Include all electrical connections to equipment provided by others. Refer to architectural and other trade drawings and specifications and final shop drawings for various connections requirements.

E. Any recommended deviation from the project specifications shall be submitted in writing with appropriate justifications (e.g., potential value engineering item). The cost estimates shall be based on the specified equipment.

B. RELATED WORK

A. The General Conditions, Supplementary Conditions, and applicable portions of Divisions 1 and 26 apply to the work of this Section as if printed herein.

B. This Specification is applicable to all electrical scope of work, including electrical portion of HVAC, Fire Alarm, Security, Tel/Data, Audio/Visual, and Building Automation systems.

C. In the event of conflict between this common Specification and any other detailed specifications, the provision of this common Specification shall govern.

C. SUBMITTALS

A. Approval of submittal documents shall extend only to determining the conformity with the general features of the contract drawings and specifications.

B. Forward all submittals in related groups. Individual or incomplete submittals are not acceptable.

C. Provide a certificate of compliance with project specifications. Identify any exceptions taken from the requirements with appropriate justification. Identify each item by manufacturer, brand, trade name, number, size, rating, or whatever other data is necessary to properly identify and check materials and equipment.

D. Identify each submittal item by reference to Specification Section paragraph in which the item is specified or drawing and detail number.

E. Organize submittals in same sequence as they appear in specification sections, articles or paragraphs.

F. Shop drawings shall show physical arrangement, construction details and finishes including:

   a. Scaled and dimensioned drawings
   b. All required maintenance access and NEC required clearances
   c. Catalog cuts and published material with scaled drawings

G. Internal wiring diagrams of equipment shall show wiring as actually furnished for this project with all optional items clearly identified as included or excluded. Clearly identify external wiring connections.

H. Prepare submittal material binders in accordance with the following:

   a. Insert all literature in standard 3-ring binders for 8-1/2” by 11” pages with individual tabs. Do not staple literature on different products together.
   b. Number all binders on the outside of the cover and indicate the Specification Section.
   c. Provide an index with binder. This index shall follow the same sequence as the specifications.

I. Provide the electronic file of all the submittals consistent with the binder sets.

J. Submittal literature, drawings, and wiring diagrams shall be specifically applicable to this project and shall not contain extraneous material or optional choices. Clearly mark literature to indicate the proposed item.

K. Submittals shall include, but not be limited to, those items listed in individual sections:

a. Identify the proposed equipment by the same designation as shown on the plans.
b. Include all physical and performance data, including materials, manufacturer's names, model numbers, weights, sizes, capacities, performance curves, finishes, colors, safety data sheets, accessories, and all other data required to completely describe equipment and to indicate complete compliance with specifications and drawings.
c. Include with complete submittals above, complete, large scale, dimensioned shop drawings, certified by manufacturer, of all major equipment and other equipment as directed by the Engineer.
d. Submittals which are not complete and/or not clearly identified as to which items are applicable will be returned without review.

L. Resubmittals will be reviewed for compliance with comments made on the original submittal only. All modifications shall be clearly marked with a resubmittal number and dated.

M. Provide factory and field testing reports and certificates.

N. Operating & maintenance instructions and manuals:

a. Subsequent to final completions and testing operations, instructed by authorized representatives in operation, adjustment, and maintenance of electrical plant.
b. Submit three (3) copies of certificate, signed by the company's representatives, attesting to their having been instructed.
c. Before personnel assume operation of systems, submit three (3) sets of operating and maintenance manuals. Bind data in vinyl covered loose-leaf binders with title index tabs identifying items therein to include:

1) Switchgear and panelboards
2) Motor control equipment
3) Transformers
4) Lighting controls
5) UPS
6) Generator and ATS
7) Fire alarm system

d. Each operating and maintenance manual shall include the following:

1) Copies of all shop drawings.
2) Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type of model shall be designated.
3) Wiring diagrams.
4) Additional information, diagrams or explanations as designated under the respective equipment or systems specification section.

e. Phone numbers and addresses of local parts suppliers and service companies.
f. Provide one (1) full size print of Record Drawing One-Line Diagram(s), in metal frame(s) with glass front. Obtain record drawing prints from the Engineer and have print installed in location as directed.
g. Provide electronic file of all documents.

O. Submit as-built drawings showing actual constructed conditions, in accordance with the provisions of Section 01 78 39 – Requirements for Contractor Turnover Packages (SRD-0106599)

D. QUALITY ASSURANCE

A. Provide materials listed and labeled by Underwriters Laboratories (UL). At the Engineer's discretion, other Nationally Recognized Testing Laboratory (NRTL) acceptable to Authority Having Jurisdiction (AHJ) may be considered.

B. Materials and systems:

a. Materials and equipment shall be provided that are standard products of Manufacturers regularly engaged in the production of such products, which are of a similar material, design, and workmanship. Standard products shall have been in satisfactory commercial use for minimum two (2) years.
b. Provide new and ship to jobsite in original manufacturer's containers or bundles.

C. All work, materials, and equipment shall comply with requirements of the applicable standards listed below. Nothing in the drawings or specifications shall be construed to permit work not conforming to applicable laws, ordinances, rules, regulations. It is not the intent of drawings or specifications to repeat requirements of codes except where necessary for completeness or clarity.

a. Americans with Disabilities Act (ADA)
b. American National Standards Institute (ANSI)
c. American Society for Testing and Materials (ASTM)
d. Inter-National Electrical Testing Association (NETA)
e. Institute of Electrical and Electronics Engineers (IEEE)
f. National Electrical Code (NEC)
g. National Electrical Manufacturer's Association (NEMA)
h. National Fire Protection Association (NFPA)
i. Uniform Building Code (UBC)
j. Underwriters Laboratories, Inc. (UL)
k. California Code of Regulations (CCR), Title 24, Energy Regulations
l. State of California Electrical Code (CEC)
m. State of California Low-Voltage Electrical Safety Orders (CAL/OSHA)
n. Codes and regulations noted in other Sections in Division 26, applicable state and local codes and ordinances.
o. Roche Group Directive K18 (Energy Conservation)
p. Roche Energy Efficiency Standards (REES)

D. If any of the requirements of the above are in conflict with one another, or with the requirements of these specifications, the most stringent requirement shall govern.

E. WARRANTY

A. Each piece of equipment shall be guaranteed to perform as specified free of defects in workmanship and material for a minimum period of one (1) year after its final acceptance.

B. Standard manufacturer's warranty shall be provided. Multiple warranties for individual components will not be acceptable.

C. At the end of the one-year warranty period, the supplier shall make a maintenance and/or service agreement available to the facility personnel.

F. DELIVERY, STORAGE AND HANDLING

A. Contractors shall refer to specific project requirements for material and products to be delivered to the project site.

B. Deliver products, materials, and equipment marked with product name, model number, and any other information needed for identification. Inspect items for shipping damage and reject damaged goods.

C. Store products, materials, and equipment as required by the manufacturer to prevent damage and degradation. Store on skids or pallets above the grade. Provide a secure, fenced, and well-lit area for outdoor storage.

D. Carefully handle, transport, and position items to prevent damage during construction.

E. Replace lost or damaged materials and equipment with new at no increase in contract cost.

G. DRAWINGS

A. For purposes of clarity, legibility, drawings are essentially diagrammatic.

B. Exact routing of wiring and locations of outlets, panels, etc., shall be governed by structural conditions, obstructions, and existing conditions. The Engineer reserves the right, at no increase in cost, to make any reasonable change in locations of electrical items, exposed at ceiling and/or on walls, to group them into orderly relationships and/or increase their utility. The Contractor shall verify the Engineer's requirements in this regard prior to roughing-in.

C. Dimensions, location of doors, partitions, and similar physical features shall be taken from architectural drawings for exact location of outlets to center with

architectural features, panels, etc., at the approximate location shown on electrical drawings.

D. Mounting heights of brackets, outlets, etc., shall be as required to match equipment served.

E. Drawings generally identify the circuit numbers serving the outlet or equipment. Circuit numbers shall indicate the power source.

F. Drawings generally indicate, the routes of all branch circuits in conduits 2” or larger.

H. COORDINATION WITH OTHER WORK

A. Site and utilities:

a. Visit and examine the site conditions prior to submitting a proposal. Site staging and storage requirements and access to all areas shall be reflected in the proposal.
b. Determine utility connection requirements and include in the base bid all costs for utility service.
c. Include all costs associated with temporary service, temporary routing of service or any other requirements of a temporary nature associated with utility service.

B. Continuity of service:

a. No service shall be interrupted or changed without written permission from the Owner. Obtain written permission before any work can be commenced.
b. When interruption of services is required, all impacted personnel shall be notified and shall agree upon a time.

C. Demolition:

a. Perform demolition, as approved by the Engineer, to accomplish new work.
b. Unless otherwise noted, remove from premises materials and equipment removed in demolition work.
c. Remove abandoned wiring back to the source. For circuits being spared, terminate wiring in a new junction box within 15’-0” of the panel source, turn off the breaker, and label the breaker as spare with wire size in panel insert. Provide circuit number and wire size on the junction box.
d. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, cap, and patch surfaces. Provide label at the end of any abandoned conduits indicating location of the other end point.
e. Provide blank cover for abandoned outlets that are not removed.
f. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.

g. Where material are to be turned over or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of materials and equipment equal to that which existed before work began. Replace damaged materials or equipment at no additional cost. Equipment noted to be removed and turned over shall be delivered at the place and time agreed by Owner.
h. Accomplish work in a neat workmanlike manner to minimize interference; annoyance or inconvenience of such work might impose on the Owner or other contractors.

D. Trade coordination:

a. Locating electrical rooms under rooms which have water intensive operational requirements is not permitted.
b. Coordinate all "tight" conditions involving work specified in this Division in advance of installation. If necessary, and before work proceeds in these areas, prepare supplementary drawings for review, showing all work in "tight" areas and additional work necessary to overcome these conditions.
c. Differences or disputes concerning coordination, interference, or extent of work between trades shall be decided by the General Contractor (GC). GC's decision, if consistent with the Contract Documents requirements, shall be final.
d. Coordinate electrical power and control wiring requirements for mechanical equipment specified in Division 23.
e. Where conflict exists between rough-in shown on drawings and that shown or required by equipment to be installed, obtain written clarification from the Architect and provide rough-in as directed.
f. Provide templates, information, and instructions to other trades to properly locate holes and openings to be cut or provided for electrical work.

E. Equipment rough-in:

a. Rough-in locations shown on electrical drawings for equipment furnished by Owner and for equipment specified in other Divisions are approximate only. Obtain exact rough-in locations from following sources:

1) From final approved shop drawings for Contractor-furnished and installed equipment.
2) From Architect for Owner-furnished, Contractor-installed equipment.

b. When the installation requires openings and access through existing construction, coordinate this work with the GC and provide the necessary requirements.
c. Verify electrical characteristics of equipment before starting rough-in. Where conflict exists between equipment and rough-in shown on Drawings, obtain clarification from the Engineer and provide as directed.
d. Unless otherwise shown or specified, provide direct raceway and conductor connections from building wiring system to equipment terminals.

e. Provide plug-in receptacle cap for cord connected equipment, which is Contractor furnished and Contractor installed, Owner furnished, and Contractor installed. Provide new cord and cap if required on Owner furnished and Contractor installed equipment.
f. Provide disconnect switches, flush type in finished spaces, where shown or required by code for direct connected equipment.

F. Concrete work:

a. Provide cast-in-place concrete as detailed in the Contract Documents unless otherwise noted.
b. All floor mounted electrical equipment shall be set on concrete housekeeping pads which are a minimum 4” in height. Concrete housekeeping pad size, height, and load capacity shall be based on the final approved equipment submittal.

G. Painting:

a. All equipment shall be furnished with factory applied finish coats, as specified.
b. If factory finish is damaged in shipment or during construction, refinish equipment to satisfaction of the Engineer.
c. Furnish one can of touch-up paint for each factory finish that matches final finished surface of the product.

PART 2 - PRODUCTS

A. MATERIALS FURNISHED

A. For similar equipment, provide equipment of one manufacturer, alike in appearance and function.

B. For equipment specified by manufacturer's number, include all accessories, controls, etc., listed in catalogue as standard with equipment. Furnish optional or additional accessories as required for proper operation or as specified.

C. Where no specific make of material or equipment is mentioned, propose product of reputable manufacturer conforming to requirements of system and other applicable specification sections for the Engineer’s approval.

D. Equipment and material damaged during transportation, installation, or operation is considered as totally damaged. Replace with new.

E. Provide an authorized representative to constantly supervise work specified in this Division; check all materials prior to installation for conformance with drawings, specifications and approved shop drawings.

F. All enclosures provided shall comply with the following NEMA enclosure types:

a. NEMA 1 – for use in dry indoor locations
b. NEMA 12 – for use in indoor locations subject to dust, dirt, and light water splashing
c. NEMA 3R – for use in wet indoor locations
d. NEMA 4X – for use in outdoor locations and indoor corrosive environment. Only 316 grade stainless steel is acceptable.

G. Voltage separation shall be adhered to in all work as noted below:

a. Separate enclosure shall be provided for any system operating at 50 VAC or less.
b. When separate enclosure is impractical (as determined by the Engineer), single enclosure may be utilized if both conditions below are met:

1) It is compartmentalized with metal barriers to provide full separation between different voltage components and wirings.
2) Higher voltage components have dead front provisions.

B. PRODUCT SUBSTITUTION

A. Acceptable manufacturers are listed in each electrical specification. The cost estimates shall be based on the specified equipment.

B. If an alternate product is proposed, a request for deviation from standard specifications shall be submitted in writing with appropriate justification (e.g., lower total cost of ownership (TCO), improved reliability, and improved safety). Written approval is required before work may proceed.

C. BUILDING STANDARDS

A. When Authority Having Jurisdiction (AHJ) has specific building standards for materials, products, methods and types of construction, these standards supersede those of other evaluation or listing agencies referenced in the Specification.

PART 3 - EXECUTION

A. INSTALLATION

A. Manufacturer's directions:

a. Installation procedures are required to be in accordance with the manufacturer's recommendations. Installation shall not proceed until printed copies of the recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

B. Workmanship:

a. Perform work in accordance with accepted standards of workmanship as recognized by the National Electrical Contractors Association (NECA).

C. Equipment:

a. Accurately set and level with supports neatly placed and properly fastened as shown and specified. Provide means of bringing in and installing equipment into position inside building.

D. Conduit systems:

a. Provide complete, integrated arrangement with like elements to make work neat appearing and finished.
b. Run concealed, unless shown or noted otherwise. Where exposed, install parallel with walls or structural elements: vertical runs plumb; horizontal runs level or parallel with structure as appropriate: groups racked together neatly with straight runs and bends both parallel and uniformly spaced.
c. Install as high as practical to maintain adequate head room shown or required. Coordinate with work of other trades to achieve proper headroom.
d. Flash and counter-flash all conduits through roof in accordance with requirements of other applicable project specifications.
e. Do not obstruct spaces required by code in front of electrical equipment, access doors, etc.
f. When providing spare conduits, provide pull string and label at both ends.

E. Penetrations:

a. Pack space between conduit sleeves in walls with non-combustible materials.
b. Make penetrations through floors water-tight with non-hardening sealant even though concealed within wall or furred space.
c. Make penetrations through any damp-proofed/water-proofed surfaces damp-proof/waterproof by appropriate means to maintain integrity of system penetrated.
d. Seal around penetrations with UL listed fireproofing material to maintain integrity of fire rating.
e. Unused sleeves and slots shall be identified for future use by permanently anchored brass nameplates identifying size and purpose of the covered slot.

F. Provide shrouds at light fixtures, electrical panelboards and like items to maintain integrity of rated wall or ceiling construction.

G. Seismic requirement:

a. The seismic design of all systems and components shall comply with Seismic Zone 4 rating. The Importance Factor shall match that of the facility.

b. Obtain the services of a registered structural engineer specialist in the design of seismic restraint members and methods of anchorage to the building structure. Submit complete calculations and shop drawing for review to the Engineer.

H. Hangers, supports, anchors and chases:

a. Support and/or anchor all equipment and wiring systems to resist gravity and seismic forces in accordance with conditions stated in the Contract Documents.
b. Supporting components shall be constructed of metal only. No wood or combustible material will be permitted including supports for outlet boxes.
c. Support materials shall be galvanized steel or 316 grade stainless steel as appropriate for the application.
d. Provide hangers, anchors, and supports for conduit runs as specified.
e. Provide concrete inserts for attachment of hangers; subject to structural engineer's review.
f. Provide anchors for floor and wall mounted equipment.
g. Provide supports for wall mounted equipment.
h. Do not support equipment or fixtures from metal roof decking.

I. Equipment protection:

a. In occupied areas, mechanical rooms and areas requiring normal maintenance access, all equipment must be guarded to protect personnel from injury.
b. Provide minimum 1/2” thick insulation product applied with adhesive on lower edges of equipment, including bus duct, cable tray, pull boxes and electrical supporting devices suspended less than 7 ft. above floors, platforms or catwalks in these areas.
c. Threaded rod or bolts shall not extend beyond supporting element and shall be protected as described above.

J. Hazardous locations:

a. Installation shall meet all requirements of NEC and applicable local electrical codes.
b. Provide devices, materials, and equipment for installation in hazardous areas that specifically approved and labeled for installation in hazardous areas of the Class, Division, and Group indicated, and are of construction that will ensure safe performance under conditions of proper use and maintenance.

3.2. RELATED WORK

A. Excavating and backfilling:

A. Provide as required for installation of electrical work in accordance with requirements of other applicable project specifications.

B. Provide all necessary shoring, sheeting and pumping.

C. In any asphalt or concrete paved areas, backfill only to subgrade level.

B. Concrete:

A. In accordance with the requirements of Division 3.

C. Sleeves, chases and concrete inserts:

A. Provide sleeves, chases, concrete inserts, anchor bolts, etc., before concrete is poured.

B. Sleeves, chases are prohibited in structural members, except where shown or approved in writing.

D. Cutting and repairing:

A. Do all cutting, repairing, including structural reinforcing, necessary for work specified in this Division. Do no proceed without written approval of the Engineer.

B. Repair damages and restore area to the original condition as deemed by the Engineer.

E. Housekeeping and cleanup:

A. Periodically as work progresses and/or as directed by General Contractor, remove waste materials from building and leave area of work broom clean.

B. Upon completion of work, remove tools, scaffolding, broken and waste materials, etc. from the site. Clean all equipment, such as panelboards, transfer switches, UPS systems, generators, starters, switches, etc., that have been installed or accessed as part of this Contract, of all dirt, dust and other foreign objects.

F. Painting and finishing:

A. Specific job requirements shall be referred to in accordance with Manufacturer's instruction for all the finishing work. All marred or damaged factory painted finishes shall be repaired with materials and procedures to match original factory finish.

B. Include surface preparation, priming and finish coating for electrical cabinets, exposed conduit, pull and junction boxes. Refer to Section 09 90 00 - Painting.

3.3. INSPECTIONS

A. Obtain and pay for all inspections required by AHJ and deliver approved inspection certificates to Owner.

3.4. TESTING AND ADJUSTING

A. Refer to 26 08 00 – Master Specification – Electrical Testing (SRD-0106016).

B. Notify Engineer and Inspectors required to observe the test when the test is ready to be performed at least two weeks prior to testing date.

C. Furnish all labor and test equipment required for testing specified in this Division.

D. All testing equipment and testing results shall be certified. Certifications shall include identification of portion of system tested, date, time, test criteria and name and title of the person signing test certification documents.

E. Maintain copies of certified tests, including those for any failed tests, at project site. At completion of project, include copies of test records and certifications in the TOP.

F. Submit test reports and certificates for review.

3.5. STARTUP AND COMMISSIONING

A. All systems and equipment shall be started, tested, adjusted and turned over to Owner ready for operation. This shall include Owner- Furnished, Contractor-Installed equipment as well.

B. Follow manufacturer's pre-startup checklist, start-up, trouble shooting and adjustment procedures. Contractor shall provide qualified personnel knowledgeable in start-up and check-out of types of systems and equipment on project.

C. Coordinate and support start-up services by manufacturer's representative where specified or where Contractor does not have qualified personnel. Coordinate start-up with all trades.

D. Provide support for the Commissioning Agent as specified in this Division and the Commissioning Plan.

3.6. EQUIPMENT IDENTIFICATION

A. Conduit Systems:

1. Conduit markers shall be installed on each system.

B. Equipment:

1. Engraved plastic laminate sign or equipment marker shall be installed on or near each major item.

C. Junction Boxes:

1. Label to identify panel designation and circuit numbers.

D. Receptacles and Switches:

1. Label to identify panel designation and circuit numbers.

E. Refer to Section 26 05 53 – Master Specification – Electrical Identification (SRD-0106015) for detailed equipment identification requirements.

3.7. POWER SYSTEM STUDY

A. General:

1. A complete Power System Study (Short Circuit Study, Coordination Study, Ground Fault Study, and Arc-flash Hazard Analysis) shall be performed by the Engineer or Record or an independent entity. Contractor shall coordinate this work and submit studies to Owner prior to receiving final acceptance of distribution equipment Shop Drawings or prior to release of equipment for manufacture. If formal completion of studies may cause delay in equipment manufacture, acceptance from Owner may be obtained for preliminary submittal of sufficient study data to ensure that selection of device ratings and characteristics will be satisfactory.

2. Studies shall include all portions of electrical distribution system from primary of service transformers down to and including 480V and 208V distribution system. Normal and emergency systems and those which result in maximum fault condition shall be adequately covered in the study.

3. Arc-flash Hazard Analysis shall be in full compliance with the SSF Site Electrical Safety Program and be extended to include all system operating at 50V and above.

4. Owner’s approved software for Power System Studies is SKM. No other software will be accepted.

5. Coordinate the detailed requirements with Owner.

3.8. TURNOVER PACKAGE (TOP) DOCUMENTATION:

A. Refer to Turnover Procedures of the Contract Documents.

B. Upon completion of work, but before final acceptance of system, submit to Engineer for approval three hard copies and one electronic file of the TOP documentation. If "one copy" is larger than 2” thick or consists of multiple volumes, submit only one set initially for review. After securing approval, submit all three hard copies to Owner.

C. Prepare and submit complete set of record drawings in accordance with Contract Documents.

3.9. CLEANING AND PAINTING

A. Properly prepare work to be finish painted as specified in other applicable project specifications.

B. Refinish damaged work supplied with final finish to satisfaction of Engineer.

C. Clean debris from panelboards, switchgear, motor starter and disconnect switch enclosures, junction boxes and pull boxes and arrange wire neatly with surplus length cut off prior to installation of covers.

D. Where louvers are provided in switchgear or transformer enclosures, vacuum louvers free of all dust and dirt.

E. Clean lighting fixture lenses and lamps at time of installation and clean lens exteriors just prior to final inspection.

F. Thoroughly clean stains, paint spots, dirt and dust on new equipment as well as existing equipment impacted under this Contract.

G. Remove temporary labels.

3.10. TRAINING

A. System training to Owner’s Representatives is of prime importance and shall be provided prior to final acceptance.

END OF SECTION 26 05 00

26 05 19

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1. WORK INCLUDED

A. This Specification provides the requirements necessary for furnishing and installation of power, lighting, control, and signaling conductors and cables rated at 600 VAC and below.

B. All required accessories associated with installation of conductors and cables including connectors, vertical supports, cable ties, insulating tapes, sealants, and heat or cold shrink tubing.

C. Deviation from the requirements of this specification shall be submitted in writing with appropriate justifications (e.g., lower total cost of ownership (TCO), improved reliability, or improved safety). Written approval is required before work may proceed.

1.2. RELATED WORK

A. This Specification shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the referenced conductors and cables. Use of this Specification without including the items listed below will result in omissions of basic requirements.

1. 26 05 00 Common Work Results for Electrical
2. 26 05 19 Conductors and Cables
3. 26 05 26 Grounding and Bonding for Electrical Systems
4. 26 05 29 Hangers and Supports for Electrical Systems
5. 26 05 33 Raceway and Boxes
6. 26 05 44 Sleeves Seals for Electrical Raceway and Cabling
7. 26 05 53 Identification for Electrical Systems
8. 26 28 16 Enclosed Switches and Circuit Breakers

B. In the event of conflict between this Specification and any other specification(s) regarding the requirements for conductors and cables, the provisions of this Specification shall govern.

1.3. REFERENCE CODES AND STANDARDS

A. The codes and standards listed below form part of this Specification but are not issued to Suppliers. Each code or standard shall be the latest revision and addendum in effect on the date this Specification is issued for construction unless noted otherwise. Except as modified by the requirements specified herein or the details of the drawings, work included in this Specification shall conform to the applicable provisions of these codes and standards

1. NFPA 70 – National Electric Code (NEC)
2. NFPA 70E – Electric Safety in the Workplace
3. UL 13 – Power-Limited Circuit Cables
4. UL 44 – Thermoset Insulated Wires and Cables
5. UL 62 – Flexible Cords and Cables
6. UL 83 – Thermoplastic-Insulated Wires and Cables
7. UL 486A-486B – Wire Connectors
8. UL 493 – Thermoplastic-Insulated Underground Feeder and Branch- Circuit Cables
9. UL 854 – Service-Entrance Cables
10. UL 1063 – Machine Tool Wires and Cables
11. UL 1685 – Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables
12. UL 1277 – Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
13. UL 1569 – Metal Clad Cables
14. UL 1581 – Electrical Wires, Cables, and Flexible Cords
15. UL 2388 – Flexible Lighting Products
16. UL 2556 – Wire and Cable Test Methods
17. ASTM B3 – Specifications for Soft or Annealed Copper Wire
18. ASTM B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
19. ASTM D2301 – Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape
20. ANSI/NEMA WC 70 – Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
21. OSHA – Standard 29 CFR 1910.305 Electrical (Wiring methods, components, and equipment for general use.)
22. NECA – The National Electrical Installation Standards (NEIS)
23. Local building codes, ordinances and regulations, including applicable seismic requirements, as required by the Authority Having Jurisdiction (AHJ)

1.4. SUBMITTALS

A. Product Data

1. Provide manufacturer's catalog cuts and technical data for each type of product within the scope of work.

B. Samples

1. Upon request, provide product samples.

C. Warranty

1. All products furnished and installed under this contract shall be warranted for a period of one (1) year upon acceptance of the unit by the Owner. The warranty shall cover 100% parts and labor.

PART 2 - PRODUCTS

2.1. ACCEPTABLE MANUFACTURERS

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

1. Power conductors and cables – American Insulated Wire, Cablec, Okonite, National, Southwire, General Cable
2. Control Cables – Belden, Alpha
3. Connectors – Burndy, 3M, Thomas & Betts, Ideal
4. Heat-shrink, Cold-shrink Tubing – 3M, Raychem
5. Vertical supports – O-Z/Gedney, Adalet
6. Sealant (above water) – Dow-Corning, General Electric,
7. Sealant (below water) – Polywater, Arnco

B. If alternate product is proposed, follow directions for Master Specification deviation in Section 1.1C.

2.2. DESIGN CRITERIA

A. General

1. Voltage rating, Insulation type, size and listing label shall be printed with permanent white markings repeated along entire length of conductor.
2. Provide all new products manufactured within 12 months of delivery to site and continuously stored where protected from heat and weather.
3. Conductor packaging and reels shall be marked or tagged with Manufacturer's name, AWG, size, voltage rating, insulation type, agency listing and date of manufacture.
4. All products furnished and installed under this scope of work shall be UL listed for the intended applications.
5. Aluminum conductor is not permitted.

B. Power and Lighting Conductors and Cables

1. Unless noted otherwise, provide single conductor insulated wire.
2. Conductors shall be copper, solid or stranded for 10 AWG and smaller, and stranded for 8 AWG and larger.
3. Insulation for conductors 10 AWG and smaller shall be THHN/THWN.
4. Insulation for conductors 8 AWG and larger shall be THHW/THWN or XHHW, 90°C dry, 75°C wet.
5. Where noted on the drawings, XHHW-2 may be used for 90°C dry and wet rating.
6. Insulation voltage rating shall be 600 VAC.
7. All power and lighting conductors shall be identified by means of color impregnated insulation, as follows:

Voltage	ØA	ØB	ØC	Neutral	Ground
120/208V	Black	Red	Blue	White	Green
277/480V	Brown	Orange	Yellow	Grey	Green

For wire sizes 8 AWG and larger, color banding tape, minimum 2 inches wide, may be used at all accessible locations in lieu of colored insulation.

8. 120 VAC circuits shall be identified as follows:

Wire	Insulation Color
Control / Signal	Red
Line power	Match phase conductor color
Neutral	White
Ground	Green or Green/Yellow

9. Switch legs and travelling wires in lighting systems shall have unique and distinct color coding to be easily identified.

C. Control and Signal Cables

1. Single or multi-conductor insulated cable with color-coded PVC insulation over each conductor and an overall PVC jacket
2. Conductor shall be stranded copper with insulation voltage rating of 600 VAC.
3. Conductors shall be suitable for installation from -20 ºC to +80 ºC.
4. Control and signal cables shall be UL 1581 listed and comply with flame testing procedure VW-1.
5. When noted on the drawings, control and signal cables shall be plenum rated and appropriately marked for installation in plenum space.

D. Tray Cable (TC)

1. When noted on the drawings install unshielded cables. UL type TC, suited for power and control application at 600 VAC.

2. TC cable shall have THHN or THWN color coded installation with 90- degree C PVC jacket and an insulated green ground conductor.

E. Underground and Direct Burial

1. For underground cable installation, use approved raceways only.
2. When direct buried cable installation is necessary and shown on the drawings, use 600 VAC rated type UF or USE cables.
3. Type UF cable shall be multi-conductor with color-coded insulations and a solid ground conductor in 90°C PVC jacket.
4. Type USE cable shall be single conductor with XLP insulation for 90°C dry and wet applications.

F. Fire Alarm Cables

1. All fire alarm wiring shall be solid conductors.
2. For wiring classifications and identification see specifications on Fire Alarm Systems.

G. Cords

1. For making connections to equipment use 600 VAC, premium-grade STO cable made of extra flexible stranded copper per UL 62 requirements.
2. Cords shall be heat resistant with oil-resistant thermoplastic insulation.

H. Metal Clad (MC) Cable

1. Factory assembled multi-conductor insulated copper conductors with insulated grounding wire in a corrugated galvanized steel sheath.

2. Termination method shall be with steel set screw connectors with integral insulating bushings. Twist-in, self-locking connectors are not acceptable.

I. Manufactured Wiring System

1. Factory assembled multi-conductor insulated copper conductors with insulated grounding wire in a corrugated galvanized steel sheath with integral locking type connectors.

J. Wiring Connectors

1. For conductors 10 AWG and smaller use spring wire connectors.
2. For conductors 8 AWG and larger use solder-less pressure connectors, compression connectors or split-bolt connectors.
3. Spring Wire type connector shall be made of zinc-coated steel spring with insulating outer jacket rated for 105ºC application. For wet/damp areas, the outer jacket shall be filled with insulating gel.
4. Compression type connector shall be made of Heavy-Duty tin plated corrosion resistant copper.
5. Solder-less pressure connector shall be tin plated insulated spade lug type rated for 105ºC application.
6. Split-bolt connectors shall be high strength copper alloy with spacer to prevent high pressure points.

K. Insulating Tape

1. Insulating tape shall be made of premium grade pressure sensitive flame retardant vinyl suitable for installation over wide variety of temperatures range as required by the application. Color shall be black.
2. The insulating tape shall have high dielectric strength and be suitable for use as primary insulation for splices at 600 VAC.

L. Grounding

1. See 26 05 26 – Grounding and Bonding for Electrical Systems for detailed grounding conductor requirements.
2. Insulated grounding conductors shall have green color insulators.

M. Splices

1. Splicing new cables is not allowed.
2. When splicing is necessary, a request with appropriate justification and manufacturer's recommended splicing method shall be forwarded to the engineer. Written approval is required before work may proceed. Minimum requirements are listed in this Specification.
3. Splice conductors only in accessible locations such as junction boxes, pull-boxes, manholes or handholes.
4. Above ground splicing of 10 AWG and smaller wire:

    a. Solder-less, screw-on, pressure connectors with integral insulation.
    b. Integral insulation shall cover the stripped conductor in its entirety.

5. Above ground splicing of 8 AWG to 4 AWG:

a. Use splice kit complete with splice hardware and insulation material produced by the same manufacturer.
b. Only compression, hex screw, or bolt clamp type made of corrosion resistant material are allowed.
c. Splice shall be insulated with UL listed material to provide insulation level equal to or greater than the conductor being spliced.
d. All hardware used shall be zinc plated steel.

6. Above ground splicing of 250 kcmil and larger:

a. Use heavy-duty sleeve or butt-splice compression connectors with minimum two compression indents.
b. Splice shall be insulated with UL listed material to provide insulation level equal to or greater than the conductor being spliced.
c. Splice hardware and insulation material shall be products of the same manufacturer.

7. For wet/damp locations, use connectors and insulators that are suitable and UL Listed for the application.
8. In manholes, handholes, and direct burial applications, use splicing methods as recommended by the cable manufacturer. The insulation dielectric strength at splices shall be equal or greater than the cable insulation. At engineer's discretion, heat shrink or cold shrink tubing may be used.
9. For VFD cable terminations and splices, use products specifically designed for the application.

PART 3 - EXECUTION

3.1. PRE-INSTALLATION

A. Verify that interior of building has been protected from weather.

B. Verify that all other work likely to damage conductors has been completed.

C. Deliver all conductors to the site on their original cable reels or in their original unbroken packages.

D. Determine cable routing prior to installation to avoid interference with other work.

E. Verify raceway segregation between different voltage levels. Any shared raceways shall be approved by the engineer prior to the start of work.

F. Verify the conduit system is completely and thoroughly swabbed before pulling cables.

3.2. INSTALLATION

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

B. Use cable lubricant for primary and secondary feeder cables or wire sizes 4 AWG and larger per manufacturer's recommendations. Avoid exceeding pulling tension, bend radius, and sidewall pressure limits at all times.

C. Install conductors in UL listed raceway systems.

D. Limited use of J-hook cable support for low voltage control or telecommunication wirings will be permitted at engineer's discretion. Do not proceed with work without written approval.

E. Pull all conductors into raceway at the same time.

F. Install control and signal wires in conduit or other approved raceway systems, unless they are specifically listed for direct installation in plenum space.

G. Seal around conductors with silicone sealant where conduit passes through exterior walls above grade.

H. For underground conduits, seal around conductors at nearest access point outside the building using foaming sealant.

I. Install cable supports for all vertical feeders.

J. Unless specifically noted on the drawings, no more than three branch circuits shall be installed in a single conduit.

K. For connection to motors, transformers, and other vibrating equipment, use stranded conductors only. The stranded conductor shall be extended from equipment to the closest fixed connection point.

L. When installing cables in manholes or handholes, all cables shall be trained around the walls with bend radius greater than ten times the overall cable diameter, or manufacturer's recommendation, whichever is greater.

M. Unless noted otherwise, existing cables shall not be re-used.

N. Unless noted otherwise on the drawings, minimum conductor sizes shall be as follows:

1. 12 AWG – Branch circuits of any kind including interior lighting
2. 14 AWG – Signal, control, and fire alarm systems
3. 10 AWG – Exterior lighting circuits

O. Route the MC Cable and manufactured wiring systems in a clean and neat manner in parallel or perpendicular to building lines. Wall penetration for MC Cable shall be perpendicular.

P. MC Cable shall be permitted in concealed dry locations from junction boxes above the ceiling to individual receptacles in the following locations:

1. Office Areas – Vertical runs only
2. Conference Rooms – Vertical runs only

3. Bath Rooms

Q. MC cable for lighting

1. MC cable shall be permitted in dry locations above ceiling for connection of lighting fixtures, limited to not more than 20’0” from junction box to first light fixture, and not more than 40’0” aggregate daisy chained from one fixture to another.
2. MC cable shall not be used for home runs

R. MC Cable shall not be permitted for the following locations:

1. Horizontal runs between receptacles
2. Non-office spaces such as laboratories, warehouses, manufacturing facilities, etc.
3. Concealed Homeruns
4. Exposed areas

S. Installation of MC Cable through fire rated wall shall be per manufacturer recommendations.

T. Manufactured wiring systems shall be permitted for final connection to the lighting fixtures. They are not permitted for homeruns.

U. Identify all power and lighting conductors in junction boxes, pull-boxes, wire-ways and other locations when cables may be accessible. Identification shall include panelboard and circuit number, or originating system designation as applicable.

V. Identify control and signal wires with wire numbers at all cabinets, panels and terminal strips. Train and lace control wiring within enclosures, and connect with suitable crimp terminals.

W. Install DC signal wiring and low voltage control wiring in separate raceways from other wiring.

X. All exposed wiring within cabinets or panels shall be arranged neatly with rounded corners and, where possible, grouped into bundles. Each bundle shall be bound with plastic ties and shall be substantially supported throughout its length. To allow for heat dissipation, power wiring shall not be grouped into packs.

Y. Make all spare wires in cabinets or panels of adequate length for connection to most remote terminal in enclosure. Terminate spare wires with insulating tape, and tag accordingly

Z. Dedicated power, neutral, and grounding conductors shall be routed to each instrument or device requiring power. Daisy-chaining of power and grounding shall not be permitted.

3.3. TESTING

A. Perform field inspection and testing.

B. Inspect for physical damage and proper connections.

C. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

D. Verify continuity of each branch circuit conductor.

E. Perform insulation resistance test on each conductor with respect to ground and adjacent

conductors. Unless otherwise recommended by the cable manufacturer, use 1000 VDC testing unit for 600 VAC cables. Apply test for one minute or until reading is constant. Minimum acceptable insulation resistance is 100 megohms for 600 VAC cables.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data for the following:
      1) Exothermic weld connectors.
      2) Mechanical connectors.
      3) Compression connectors.
      4) Specialty tools.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL:
   a. Confirm conformance with UL standards.
   b. Supply with an applied UL listing mark.

PART 2 - PRODUCTS

2.01 GROUND ROD

A. Material: Copper.

B. Diameter: Minimum 3/4 inch.

C. Length: 10 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Use low-smoke, low-emission process.
3. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and anti-seizing compound and sealed.
5. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Burndy Corp.; Hyground Irreversible Compression.
   b. Thomas and Betts Co.
   c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Burndy Corp.
   b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast-iron riser ring and traffic cover marked “GROUND ROD.”

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

1. Christy Co.
2. Lightning and Grounding Systems, Inc.

PART 3 - EXECUTION

3.01 GENERAL

A. Grounding: In compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Use furnished ground lug in motor connection box. If none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing. Install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 GROUNDING WELLS

A. Install for ground rods located inside buildings, asphalt and paved areas, and where shown on Drawings.

B. Install riser ring and cover flush with surface.

C. Place 12 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Above-grade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Below-grade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.

2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.

B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.

B. Bond neutrals of substation transformers to substation grounding grid and system grounding network.

C. Bond neutrals of pad-mounted transformers to locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 GROUNDING ELECTRODE SYSTEM

A. Bonding:

1. Bond to Main Conductor System:
   a. Roof-mounted ventilators, fans, air handlers, masts, flues, cooling towers, handrails, and other sizeable metal objects.
   b. Roof flashing, gravel stops, insulation vents, ridge vents, roof drains, soil pipe vents, and other small metal objects if located within 6 feet of main conductors or another grounded object.
2. Bond each steel column or major framing members to grounding system.
3. Bond each main down conductor to grounding system.

B. Grounding System:

1. Grounding Conductor:
   a. Completely encircle building structure.
   b. Bury minimum 1 foot below finished grade.
   c. Minimum 2 feet from foundation walls.
2. Interconnect ground rods by direct-buried copper cables.
3. Maximum Resistance: 5 ohms when connected to ground rods.
4. Connections:
   a. Install ground cables continuous between connections.

b. Exothermic welded connections to ground rods, cable trays, structural steel, handrails, and buried and nonaccessible connections.
c. Provide bolted clamp type mechanical connectors for all exposed secondary connections.
d. Use bolted offset parapet bases or through-roof concealed base assemblies for air terminal connections.
e. Provide interconnections with electrical and telephone systems and all underground water, gas, and sewer metal pipes.
f. Provide electric service arrestor ground wire to building water main.

3.11 LIGHTNING PROTECTION SYSTEMS

A. Bond lightning protection system ground terminals to building or structure grounding electrode system.

3.12 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1. SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2. RELATED REQUIREMENTS

A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.

1.3. 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. MFMA-4 - Metal Framing Standards Publication; 2004.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4. 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 Owner 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.

1.5. SUBMITTALS

A. See Section on 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, and post-installed concrete/masonry anchors.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6. QUALITY ASSURANCE

A. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with the following. Where requirements differ, comply with most stringent.
   a. NFPA 70.
   b. Requirements of authorities having jurisdiction.
2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical 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. 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 and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. ABB: www.electrification.us.abb.com/#sle.
   b. Eaton Corporation: www.eaton.com/#sle.
   c. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
2. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
3. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. 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.
3. Channel Material:
   a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch wide by 13/16 inch high.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

1. Minimum Size, Unless Otherwise Indicated or Required:
   a. Equipment Supports: 1/2-inch diameter.
   b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
   c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
   d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
   e. Outlet Boxes: 1/4-inch diameter.
   f. Luminaires: 1/4-inch diameter.

F. 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 Masonry: Use toggle bolts.

5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Powder-actuated fasteners are not permitted.
    a. Where approved by Owner.
8. Hammer-driven anchors and fasteners are not permitted.
9. 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.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install hangers and supports in accordance with NECA 1.
C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
D. Unless specifically indicated or approved by Owner, do not provide support from suspended ceiling support system or ceiling grid.
E. Unless specifically indicated or approved by Owner, 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:
H. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
I. 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.
J. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
K. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
M. Secure fasteners in accordance with manufacturer's recommended torque settings.
N. Remove temporary supports.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAY AND BOXES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
   e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   f. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   g. VE 1, Metallic Cable Tray Systems.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
7. UL:
   a. 1, Standard for Safety for Flexible Metal Conduit.
   b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
   c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
   d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum,

Red Brass and Stainless.

e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
g. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
h. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
i. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
j. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
k. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
l. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's Literature:
   a. Rigid galvanized steel conduit.
   b. Electrical Metallic Tubing
   c. Flexible metal, liquid-tight conduit.
   d. Conduit fittings.
   e. Wireways.
   f. Surface metal raceway.
   g. Junction and pull boxes used at or below grade.
   h. Large junction and pull boxes.
   i. Terminal junction boxes.
2. Precast Manholes and Handholes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.
3. Telecommunications Pathway Cable Tray:
   a. Dimensional drawings, calculations, and descriptive information.
   b. NEMA load/span designation and how it was selected.
   c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
   d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
   e. Layout drawings and list of accessories being provided.
4. Cable Tray Systems:
   a. Dimensional drawings, calculations, and descriptive information.
   b. NEMA load/span designation and how it was selected.
   c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.
   d. Location and magnitude of maximum simple beam deflection of tray

for loading specified.

e. Layout drawings and list of accessories being provided.

5. Equipment and machinery proposed for bending metal conduit.
6. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
7. Conduit Layout:
    a. Provide drawings for conduit installations underground and concealed conduits including, but not limited to ductbanks, under floor slabs, concealed in floor slabs, and concealed in walls.
    b. Provide plan and section showing arrangement and location of conduit and duct bank required for:
        1) Low and medium voltage feeder and branch circuits.
        2) Instrumentation and control systems.
        3) Communications systems.
        4) Empty conduit for future use.
    c. Reproducible; electronic CAD; scale not greater than 1 inch equals 20 feet.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

B. Rigid Galvanized Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS / RMC):

1. Meet requirements of ANSI C80.1 and UL 6.
2. Material: Hot-dip galvanized with chromated protective layer.

B. Electrical Metallic Tubing - Steel (EMT):

1. Meet requirements of ANSI C80.3 and UL 797.

C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.

D. Innerduct:

1. Resistant to spread of fire, per requirements of UL 2024.
2. Textile Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Maxcell.

2.02 FITTINGS

A. Electrical Metallic Tubing Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type:
      1) Base Metal: low-carbon steel
      2) Interior Coating: corrosion-resistant organic coating
      3) Exterior Coating: galvanized steel
2. Support and Securing:
   a. Must be securely fastened within 3 feet of each box, cabinet, or termination fitting, and supported at least every 10 feet thereafter.
3. Bends:
   a. Total bends between pull points (boxes or cabinets) cannot exceed 360 degrees (four 90-degree bends).
4. Bushing:
   a. Material: made from non-metallic, durable plastic polymers such as polyethylene or high-impact thermoplastic.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Arlington Industries.
2) American Fittings.
3) Halex.

5. Grounding Bushing:
   a. Material: threadless set-screw grounding bushing or a push-on EMT grounding bushing made of plastic/nylon liner combined with a grounding lug.
   b. Lay-in Lug Bushing: Equipped with an open-faced (lay-in) terminal lug, to slip the grounding wire into the lug without needing to feed the bare end straight through a small hole.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Bridgeport Fittings.
      2) Arlington Industries.
      3) Garvin Industries,
6. Conduit Hub:
   a. Material: Die-cast zinc, copper-free aluminum, or 316 stainless steel.
   b. UL listed for use in wet locations.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Lincoln Foundry.
      2) Dynacast.
      3) Zetwerk.
7. Conduit Bodies:
   a. Material: Manufactured from lightweight, corrosion-resistant, copper-free die-cast aluminum and sized as required by NFPA 70. Permitted for wire splices provided the cubic-inch capacity is marked inside the body and fill limits are respected.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following (For Normal Conditions):
      1) Arlington Industries.
      2) Orbit Industries.
      3) Atkore (via brands like Calconduit and Allied Tube & Conduit).

B. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Subject to compliance with requirements, manufacturers offering products

that may be incorporated into the Work include, but are not limited to, the following:
1) Appleton; Series BU-I.
2) O-Z/Gedney; Type HB.

3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Appleton; Series GIB.
      2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Appleton, Series HUB-B.
      2) O-Z/Gedney; Series CH.
      3) Meyers; ST Series.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following (For Normal Conditions):
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.
      2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.

8. Conduit Sealing Fitting:
    a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Appleton; Type EYF, EYM, or ESU.
        2) Crouse-Hinds; Type EYS or EZS.
        3) Killark; Type EY or Type EYS.
9. Drain Seal:
    a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Appleton; Type EYD.
        2) Crouse-Hinds; Type EYD or Type EZD.
10. Drain/Breather Fitting:
    a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Appleton; Type ECDB.
        2) Crouse-Hinds; ECD.
11. Expansion Fitting:
    a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Deflection/Expansion Movement:
            a) Appleton; Type DF.
            b) Crouse-Hinds; Type XD.
        2) Expansion Movement Only:
            a) Appleton; Type XJ.
            b) Crouse-Hinds; Type XJ.
            c) Thomas & Betts; XJG-TP.
12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
    c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Appleton; CG-S.
        2) Crouse-Hinds; CGBS.

C. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Thomas & Betts; Series 5331.
b. O-Z/Gedney; Series 4Q.

D. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: O-Z/Gedney; Type FSK or Type WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

A. Cast Metal:

1. Box: Malleable iron.
2. Cover: Gasketed, weatherproof, malleable iron with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast mounting.
5. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: for Nonhazardous Locations:
   a. Crouse-Hinds; Type FS or Type FD.
   b. Appleton; Type FS or Type FD.
   c. Killark.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Cast Metal Box:

1. NEMA 250 Type 4.
2. Box: Cast malleable iron with drilled and tapped conduit entrances and exterior mounting lugs.

3. Cover: Hinged with screws.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Surface Mounted, Hinged Type:
   a. Crouse-Hinds.
   b. O-Z/Gedney; Series YW.

D. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Christy, Concrete Products, Inc.; B1017BOX.
   b. Utility Vault Co.; 3030 SB.

2.05 METAL WIREWAYS

A. Meet requirements of UL 870.

B. Type: Stainless steel-enclosed, lay-in type.

C. Cover: Removable, screw type.

D. Rating: Outdoor raintight.

E. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.

F. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by spring nuts or otherwise guarded to prevent wire insulation damage.

G. Knockouts: Without knockouts, unless otherwise indicated.

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

1. Circle AW.
2. Hoffman.
3. Square D.

2.06 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover.

E. Raceway Entrances:

1. Provide on all four sides.
2. Provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.
2. Wall Attachment:
   a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
   b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
   c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
   a. Above 600 Volts: ELECTRIC HV.
   b. 600 Volts and Below: ELECTRIC LV.
   c. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on of checkered design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
   a. 600 Volts and Below: ELECTRIC LV.
   b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

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

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.07 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
   a. Nonmetallic, interlocking, for multiple conduit sizes.
   b. Suitable for all types of conduit.
   c. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Underground Device, Inc.

2) Carlon.

2. Template Type:
   a. Nonmetallic, custom made one-piece spacers.
   b. Suitable for all types of conduit.
   c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
   d. Conduit openings cut 1 inch larger than conduit outside diameter.
   e. Additional openings for stake-down, rebar, and concrete flow through as required.
   f. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: SP Products; Quik Duct.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, nonferrous metal.
   b. Shape: Round.
   c. Raceway Designation: Pressure stamped, embossed, or engraved.
   d. Tags relying on adhesives or taped-on markers not permitted.

2. Warning Tape:
   a. Material: Polyethylene, 4-mil gauge with detectable strip.
   b. Color: Red.
   c. Width: Minimum 6 inches.
   d. Designation: Warning on tape that electric circuit is located below tape.
   e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.
   f. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Panduit; Type HTDU.
      2) Reef Industries; Terra Tape.
3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
   b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
   c. Minimum Dimension: 1/4 inch thick, 10 inches long, and 3/4 inch wide.

C. Raceway Coating: Clean and paint in accordance with Section 09 90 00, Painting and Coating.

D. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.

4. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Raychem.
   b. 3M.

E. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot- melt adhesive.
2. Width: 50 mm minimum.
3. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Aluminum Conduit: Do not install in direct contact with concrete. Install in PVC sleeve or cored hole through concrete walls and slabs.

G. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

H. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

I. Group raceways installed in same area.

J. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

K. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

L. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

M. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

N. Install watertight fittings in outdoor, underground, or wet locations.

O. Paint threads and cut ends, before assembly of fittings, galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

P. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

Q. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.

R. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

S. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

T. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 REUSE OF EXISTING CONDUITS

A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.

1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
2. Conduit is sized per the NEC.
3. Conduit is of the type specified in Contract Documents.
4. Conduit is supported as specified in Contract Documents.

B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4 inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including fittings.

B. Conduit placement shall not require changes in reinforcing steel location or

configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.

E. Slabs and Walls (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.04 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed: Rigid Galvanized Steel (RGS).

C. Interior, Exposed: Electrical Metallic Tubing (EMT) - except in locations where subject to physical damage then RGS shall be used to an appropriate height.

~~D.~~ Interior, Concealed (Not Embedded in Concrete): Electrical Metallic Tubing (EMT) - except in locations where subject to physical damage then RGS shall be used to an appropriate height.

E. Concrete-Encased Ductbank, Above 480V: PVC

F. Transition from Underground or Concrete Embedded to Exposed: RGS

3.05 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible, flexible metal liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.
5. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 and 2 areas.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.06 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating using fire penetration seal as specified in Section 07 92 00, Joint Sealants.

D. Apply single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide non-shrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal

device on each side.

c. With Concrete Encasement: Install watertight entrance seal device on accessible side.

d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.

e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.

3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
4. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
6. Manholes and Handholes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.07 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 8 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow percent extra space for future conduit.

C. Application/Type of Conduit Strap:

1. Rigid Steel Conduit: Zinc coated steel, pre-galvanized steel or malleable iron.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
   a. Dry, Noncorrosive Areas: Galvanized.
   b. Wet, Noncorrosive Areas: Stainless steel.
   c. Corrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

F. Support aluminum conduit on concrete surfaces with stainless steel or nonmetallic spacers, or aluminum or nonmetallic framing channel.

3.08 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.09 EXPANSION/DEFLECTION FITTINGS

A. Provide on raceways at structural expansion joints, in long tangential runs and where conduit stubs up above grade or through slab.

B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.10 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.11 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's pre-molded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Electrical Metallic Tubing: Provide gland compression, insulated connectors.
4. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
5. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.

C. Switchboard, Switchgear, and Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or

grounding pad.

3.12 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Transition from Underground to Exposed: rigid steel conduit.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground.

K. Concrete Encasement:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Concrete Color: Red.

L. Backfill:

1. As specified in Section 31 23 23.15, Trench Backfill. Controlled low strength fill is an acceptable bedding and pipe zone material.
2. Do not backfill until inspected by Engineer.

3.13 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.14 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
    a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
    a. Dimensions given to centerline of box.
    b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
    c. Do not straddle CMU block or other construction joints.
2. Light Switch:
    a. 48 inches above floor.
    b. When located next to door, install on lock side of door.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet:
    a. 15 inches above floor.
    b. 6 inches above counter tops.
    c. Wall Mounted: 52 inches above floor.
5. Convenience Receptacle:
    a. General Interior Areas: 15 inches above floor.
    b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of backsplash, or 6 inches above counter tops without backsplash.
    c. Industrial Areas, Workshops: 48 inches above floor.
    d. Outdoor Areas: 24 inches above finished grade.

6. Special-Purpose Receptacle: 24 inches above floor or as shown.
7. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

E. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.15 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three

right-angle bends.

B. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

C. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

F. Install drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.16 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

B. Do not install until final raceway grading has been determined.

C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.17 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.18 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.

2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
3. Install tags at each terminus for concealed raceways.
4. Provide noncorrosive wire for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.

C. Buried Raceway Marker:

1. Install at grade to indicate direction of underground raceway.
2. Install at bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.19 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage

during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION 26 05 33

SECTION 26 05 44

SLEEVES SEALS FOR ELECTRICAL RACEWAY AND CABLING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification.

B. 26 04 00 Basic Electrical Requirements 3.6 Firestopping for penetrations of fire rated construction

C. Section Includes:

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

1.2 REFERENCE STANDARDS

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

1.3 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures, for submittal procedures.

B. Product Data: Provide manufacturer's standard data sheets.

C. Turn Over Package (TOP)

1. Upon completion of the project, contractor shall submit TOP as specified in 01 78 39 – Master Specification –Requirements for Contractor Turnover Packages

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves

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

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

C. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.

2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than fifty (50) inches and with no side larger than sixteen (16) inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter fifty (50) inches or more and one or more sides larger than sixteen (16) inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Sleeve-seal systems in this article are used for conduit penetrations in slabs-on-grade and in below- grade exterior walls.

B. Acceptable Manufacturers:

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc
c. The Metraflex Company
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. If alternate product is proposed, follow directions for Master Specification deviation in Section 1.1C

C. If alternate product is proposed, follow directions for Master Specification deviation in Section
1.1C.

D. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

E. Pressure Plates: Stainless steel.

F. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

B. Acceptable Manufacturers:

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

    a. Presealed System

2. If alternate product is proposed, follow directions for Master Specification deviation in Section 1.1

2.4 GROUT

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

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

C. Design Mix: 5,000-psi, twenty-eight (28) day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

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

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

C. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. No spray expansion form will be allowed for sealing conduits, fire, etc.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

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

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

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

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

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

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

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

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

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

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

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

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

B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

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

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

C. Secure nailing flanges to concrete forms.

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

END OF SECTION 26 05 44

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Extruded insulating tubing.
3. Bands.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.

B. Related Requirements:
1. This Specification shall be used in conjunction with the other specifications and related Contract Documents.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN PGDQ2 for components; including UL 969.

B. UL PGDQ2 - Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. 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. Brady Corporation.
    b. Champion America.
    c. Grafoplast Wire Markers.
    d. HellermannTyton.
    e. LEM Products Inc.
    f. Marking Services Inc.
    g. Panduit Corp.
    h. Seton Identification Products; a Brady Corporation company.
    i. emedco.

C. UL PGDQ2 - Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. 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. A'n D Cable Products.
    b. Brady Corporation.
    c. Brother International Corporation.
    d. Grafoplast Wire Markers.
    e. Ideal Industries, Inc.
    f. LEM Products Inc.
    g. Marking Services Inc.
    h. Panduit Corp.
    i. Seton Identification Products; a Brady Corporation company.
    j. emedco.

2. Self-Lamination: Clear; UV-, weather-, and chemical-resistant; self-laminating, with protective shield over legend. Size labels such that clear shield overlaps entire printed legend.
3. Marker for Labels:

    a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
    b. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. UL PGDQ2 - Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

1. 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. A'n D Cable Products.
    b. Brady Corporation.
    c. Brother International Corporation.
    d. Grafoplast Wire Markers.

e. HellermannTyton.
f. Ideal Industries, Inc.
g. LEM Products Inc.
h. Marking Services Inc.
i. Panduit Corp.
j. Seton Identification Products; a Brady Corporation company.
k. emedco.

2. Minimum Nominal Size:

a. 1-1/2 by 6 inch for raceway and conductors.
b. 3-1/2 by 5 inch for equipment.
c. As required by authorities having jurisdiction.

2.2 EXTRUDED INSULATING TUBING

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN YDPU2 for components; including UL 224.

B. UL YDPU2 - Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F.

1. 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. Brady Corporation.
b. Panduit Corp.

2.3 BANDS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

1. 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. Brady Corporation.
b. HellermannTyton.
c. Marking Services Inc.
d. Panduit Corp.
e. Seton Identification Products; a Brady Corporation company.

B. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.

1. 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. Brady Corporation.

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. 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. Brady Corporation.
b. Carlton Industries, LP.
c. Champion America.
d. HellermannTyton.
e. Ideal Industries, Inc.
f. Marking Services Inc.
g. Panduit Corp.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.

1. 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. Brady Corporation.
b. Carlton Industries, LP.
c. Marking Services Inc.
d. emedco.

C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.

1. 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. HellermannTyton.
b. LEM Products Inc.
c. Marking Services Inc.
d. Pipemarker.com; Brimar Industries, Inc.
e. Seton Identification Products; a Brady Corporation company.

D. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with [black and white] [yellow and black] stripes and clear vinyl overlay.

1. 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. Brady Corporation.
    b. Carlton Industries, LP.
    c. Seton Identification Products; a Brady Corporation company.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch.

2.5 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. 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. Brady Corporation.
    b. Carlton Industries, LP.
    c. Marking Services Inc.
    d. Seton Identification Products; a Brady Corporation company.
    e. emedco.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened or printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:
1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags:

    a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
    b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Baked-Enamel Signs:

1. 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. Brady Corporation.
    b. Carlton Industries, LP.
    c. Champion America.
    d. Marking Services Inc.

e. emedco.

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

B. Metal-Backed Butyrate Signs:

1. 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. Brady Corporation.
   b. Champion America.
   c. Marking Services Inc.
   d. emedco.

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

C. Laminated Acrylic or Melamine Plastic Signs:

1. 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. Brady Corporation.
   b. Carlton Industries, LP.
   c. Marking Services Inc.
   d. Seton Identification Products; a Brady Corporation company.
   e. emedco.

2. Engraved legend.
3. Thickness:

   a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
   b. For signs larger than 20 sq. inch, 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners with 1/4 inch grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN ZODZ; including UL 1565 or UL 62275.

B. UL ZODZ - General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

C. UL ZODZ - UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

D. UL ZODZ - Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection and fire-alarm equipment must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.

B. Pipe and Conduit Labeling: Comply with ASME A13.1 and IEEE C2.

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

1. Color must be factory applied.
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 480Y/277 V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

4. Color for Neutral (Grounded Conductor): White.
5. Color for Equipment Ground: Green.
6. Color for Isolated Ground: Green with two or more yellow stripes.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

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

H. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage and system or service type with black letters on orange field.

I. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage and system or service type with black letters on orange field.

J. Conductors to Be Extended in Future: Attach write-on tags to conductors and list source.

K. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

L. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: Self-adhesive label.
3. Outdoor Equipment: Laminated acrylic or melamine sign.
4. Equipment to Be Labeled:

    a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
    b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
    c. Enclosures and electrical cabinets.
    d. Access doors and panels for concealed electrical items.
    e. Switchboards.
    f. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
    g. Emergency system boxes and enclosures.
    h. Enclosed switches.
    i. Enclosed circuit breakers.
    j. Enclosed controllers.
    k. Variable-speed controllers.
    l. Push-button stations.
    m. Power-transfer equipment.
    n. Contactors.
    o. Remote-controlled switches, dimmer modules, and control devices.
    p. Battery-inverter units.
    q. Battery racks.
    r. Power-generating units.
    s. Monitoring and control equipment.

N. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E requirements for arc-flash hazard warning labels.
2. Raceways and Cables Carrying Circuits at More Than 1000 V:

    a. Black letters on orange field.
    b. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

3. Multiple Power Sources Warning Legend: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
4. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. 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. Controls with external control power connections.

E. Operating Instruction Signs: Self-adhesive labels.

F. Emergency Operating Instruction Signs: Self-adhesive labels [Baked-enamel warning signs] with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

3.4 SELECTION OF IDENTIFICATION PRODUCTS FOR COMMUNICATIONS, CONTROL, AUXILIARY, AND LIFE SAFETY SYSTEMS

A. Comply with relevant sections of communications.

3.5 INSTALLATION

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

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes typical for electrical equipment environments.

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

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

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

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

G. Verify identity of item before installing identification products.

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

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

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

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

L. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.

M. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

N. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.

O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.

Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.

R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

U. Metal Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized ,plenum-rated for plenum spaces cable ties.

V. Nonmetallic Preprinted Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose, UV-stabilized, plenum-rated for plenum spaces cable ties.

W. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

X. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

Y. Metal-Backed Butyrate Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

Z. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 26 05 53

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Specification includes disconnect switches located remote from panelboards for disconnection of power to electrical equipment.

B. Deviation from the requirements of this Specification shall be submitted in writing with appropriate justifications (e.g., lower total cost of ownership (TCO), improved reliability, or improved safety). Written approval is required before work may proceed.

1.2 RELATED WORK

A. This Specification shall be used in conjunction with the other specifications and related Contract Documents.

1.3 REFERENCES

A. The codes and standards listed below form part of this Specification, but are not issued to Suppliers. Each code or standard shall be the latest revision and addendum in effect on the date this Specification is issued for construction unless noted otherwise. Except as modified by the requirements specified herein or the details of the drawings, work included in this Specification shall conform to the applicable provisions of these codes and standards.

1. Local building codes, ordinances and regulations, including applicable seismic requirements, as required by the Authority Having Jurisdiction (AHJ).
2. UL 98 – Enclosed and Dead-Front Switches.
3. NEMA KS1 – Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
5. NEMA FU 1 – Low Voltage Cartridge Fuses.
6. NEMA AB 1 – Molded Case Circuit Breakers.
7. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4 SUBMITTALS

A. Product Data: In addition to requirements for Contractor Turnover Packages, provide the following information:
1. Voltage, amperage, ratings, fuse clip features, terminal lugs, trip units, time-current curves.
2. Enclosure details including type and dimensions.

3. Details of all accessories and safety features.

B. Instruction Manuals: Provide factory published documents including the following:

1. Installation manual.
2. Operating and maintenance manuals.
3. Recommended spare parts list.
4. Additional information, diagrams or explanations required for proper installation, operation and maintenance of the equipment.

C. Quality Assurance

1. The equipment Manufacturer shall be ISO 9001 or 9002 certified. A copy of the certification shall be provided upon request.
2. All components and assemblies supplied under this Specification shall be UL listed for the intended applications.

D. Warranty

1. All equipment furnished and installed under this contract shall be warranted for a minimum period of one (1) year upon acceptance of the unit by the Owner. The warranty shall cover 100% parts and labor.
2. The warranty must be provided by the system manufacturer and multiple warranties for individual components will not be acceptable.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Eaton / Cutler-Hammer
2. Square D / Schneider Electric
3. Allen-Bradley / Rockwell
4. ABB
5. Siemens
6. General Electric

2.2 DESIGN CRITERIA

A. Non-fused Disconnect Switches:

1. Provide non-fused disconnect switches unless otherwise noted on the drawings.
2. Disconnect switches shall be rated for the maximum available fault current at the point of connection
3. Switch blades shall be fully visible in "OFF" position when switch door is open.
4. Switches shall have removable arc suppressors to permit easy access to line side lugs.
5. Lugs shall be front removable and UL listed for 60ºC or 75ºC copper wires.
6. Switches shall be quick-make, quick-break type.

7. Operating handle shall be integral part of the enclosure. Handle position shall indicate whether switch is "ON" or "OFF".
8. Disconnect shall be capable of being locked in OFF position with three padlocks.
9. Disconnect switches shall be equipped with an external handle interlocked with the door so that the handle must be in the “OFF” position before the door can be opened. A mechanism shall be provided that can be operated with a maintenance tool to defeat this interlock.
10. Disconnect switches for VFD controlled motors shall be designed to signal the VFD to execute a stop command before motor can be safely disconnected from the VFD. Coordinate this requirement with the VFD manufacturer.

B. Fused Disconnect Switches:

1. When noted on the drawings, provide fused disconnect switches of the size and ratings indicated.
2. Fuse clips shall be as required for the application.
3. Fusible switches rated 100 thru 600 amperes at 240 volts and 30 through 600 amperes at 600 volts shall be UL listed for field conversion from Class H to Class J fuse spacing. Switch also must accept Class R fuses and have provisions for field installation of UL listed rejection mechanism to reject all fuses except Class R.
4. For Class R or Class J fuses, the UL listed short circuit rating of switches shall be 200,000 rms symmetrical amperes when operated with appropriate rejection scheme.
5. For Class H, the UL listed short circuit rating of switches shall be 10,000 rms symmetrical amperes.
6. Fusible switches rated 800 thru 1200 ampere shall have provisions for Class L fuses and shall be UL listed for short circuit rating of 200,000 rms symmetrical amperes.

C. Circuit Breaker Switches:

1. When noted on the drawings, provide enclosed circuit breaker switches of the size and ratings indicated.
2. Circuit breaker switches shall be equipped with molded-case breakers confirming to UL 489 requirement.

D. Enclosures:

1. Enclosures shall meet NEMA KS 1 requirements. Provide General Duty switches for non-critical applications. For critical applications provide Heavy Duty switches. For classified areas, provide switches specifically designed for the intended application.
2. Enclosures shall be steel and meet environmental conditions of the installation space.
3. For interior dry space provide NEMA 1 enclosures.
4. For exterior space provide NEMA 4X stainless steel or IP66 rated enclosures.
5. For damp, wet or corrosive spaces, provide NEMA 4X stainless steel or IP66 rated enclosures.

E. Accessories:

1. Provide solid neutral assembly.
2. Provide equipment ground kit.
3. Provide blown fuse indicators on fused switches.
4. Provide factory installed fuse puller on fused switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install local disconnect switches as indicated on the drawings or as required by the AHJ. As a minimum, provide local disconnects for:

1. Any equipment and/or motor where the power source is not apparent, or may be difficult to locate during an emergency, as determined by the site SHE representative.
2. Motors, if the starter is within line of sight of the motor and no more than 50 feet away.
3. Fixed electric space heating equipment.
4. Air conditioning and refrigeration equipment with hermetic motors.

B. Disconnect switches shall be easily accessible and mounted at 5 feet AFF to centerline of handle

1. Install disconnect switches plumb.
2. Verify that local disconnect switches for VFD driven motors are installed in full compliance with the VFD manufacturer's recommendations.

C. Provide non-fused disconnect device for motors located more than 25 feet horizontally from overcurrent protective device.

1. Provide non-fused disconnect device for motors located on roof or located on floor different from overcurrent protective device.
2. Provide fuses for fusible disconnect switches.
3. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 SITE ACCEPTANCE TEST

A. Field acceptance tests shall be performed in full compliance with manufacturer's recommended methods.

3.3 ADJUSTING AND CLEANING

A. Final adjustments shall be made and equipment shall be thoroughly cleaned prior to final inspection and connection to power source. Damaged equipment shall be repaired immediately.

3.4 SPARE PARTS

A. Provide factory recommended spare parts, including spare fuses, as indicated in approved submittals.

END OF SECTION 26 28 16

City of Manchester - Department of Aviation

Manchester - Boston Regional Airport

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT PROJECT

CITY PROCUREMENT No.: RFP #2600049

AIP 3-33-0011-TBD-2026

TECHNICAL SPECIFICATIONS

APPENDIX A

OCTOBER 2026

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NOTES:

1. THE FINAL WORK AREAS LIMITS AND CONFIGURATION, SCHEDULING, AND BARRICADES SHALL BE SUBJECT TO COORDINATION WITH THE OWNER DURING THE CONSTRUCTION PHASE.
2. ONLY ONE TEMPORARY SHORT-TERM CONTRACTOR WORK AREA IN THE ROADWAYS CAN BE CAPTURED AT A TIME.
3. THE GATE-7 CAPTURE AREA SHALL NOT BE USED FOR THE STORAGE OF MATERIALS, TOOLS, OR EQUIPMENT OUTSIDE OF PERIODS OF SHORT-TERM PREPARATIONS AND ACTIVE CONSTRUCTION WORK.

AMMON DRIVE

APPROX. 2,280 FT. FROM AHU-6 LIFT POINT TO CENTERLINE OF RWY 6/24

CONTRACTOR SITE ACCESS ROUTE (TYP.)

APPROX. CONTRACTOR TOOL TRAILER(S) & LAYDOWN & PARKING AREA

GREEN DRIVE

TWO ELECTRIC VEHICLE CHARGING STALLS TO REMAIN ACCESSIBLE

RTU-1

RTU-2

APPROX. LIMITS OF TEMPORARY STORM-TERM CONTRACTOR WORK AREA FOR CRANE(S) AND EQUIPMENT TO REMOVE / REPLACE RTU-1 AND RTU-2

AIRFIELD SECURITY VEHICLE GATE #28. CONTRACTOR ACCESS - ESCORT REQUIRED

Gate 15A

Gate 15

MAINTAIN PUBLIC & LIMO/SHUTTLE VEHICULAR TRAFFIC (MIN. 12 FT WIDE LANE + 1 FT CLEAR.) DURING WORK AREAS CAPTURE (EXCEPT SHORT-DURATION REROUTE TO DURING CRANE LIFT)

AIRPORT ROAD (ONE WAY)

RTU-3

SHORT-TERM NIGHT-TIME CLOSURE OF CIRCULATION/CURB ROAD (1:30 AM - 4:30 AM) FOR RTU-5 REMOVAL /REPLACEMENT CRANE LIFT

APPROX. LIMITS OF TEMPORARY SHORT-TERM CONTRACTOR NIGHT-WORK AREA (1:30AM-4:30 AM) FOR CRANE(S) AND EQUIPMENT TO REMOVE / REPLACE RTU-5

RTU-4

RTU-5

Gate 1

Gate 14

LOWER (VALLEY) ROOF HEIGHT AT AHUs IS APPROX. 18 FT. ABOVE TERMINAL GROUND FLOOR LEVEL

AHU-5

APPROX. LIMITS OF TEMPORARY SHORT-TERM CONTRACTOR WORK AREA FOR CRANE(S) AND EQUIPMENT TO REMOVE / REPLACE RTU-3 AND RTU-4

Gate 2

Gate 12

APPROX. 1,860 FT. FROM AHU-5 LIFT POINT TO CENTERLINE OF RWY 17/35

AHU-6

AHU-7

UPPER ROOF HEIGHT APPROX. 34 FT. ABOVE TERMINAL RAMP LEVEL

Gate 3

Gate 11

APPROX. LIMITS OF TEMPORARY SHORT-TERM CONTRACTOR WORK AREA FOR CRANE(S) AND EQUIPMENT TO REMOVE / REPLACE AHU-5. CONTRACTOR TO PROVIDE BARRICADES ACCORDING TO CSPP. SEE GENERAL NOTES AND ACCESS DETAILS DRAWING

Gate 4

Gate 5

Gate 6

Gate 7

Gate 8

Gate 9

Gate 10

BOLTON & MENK
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Manchester-Boston REGIONAL AIRPORT

PROJECT DESIGNER:

SCALE: 1: 30
DATE: 08/31/2026
DESIGNED BY: XX
DRAWN BY: XX
CHECKED BY: XX
APPROVED: XX

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 2600028

HVAC GENERAL SITE PLAN

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

PROJ. NO.: 26X.144256
BMI FILE: xxx/xx
AIP NO.: 3-33-0011-TBD-2026

DRAWING NO.
GP-1
SHEET xx OF xx
REV xx

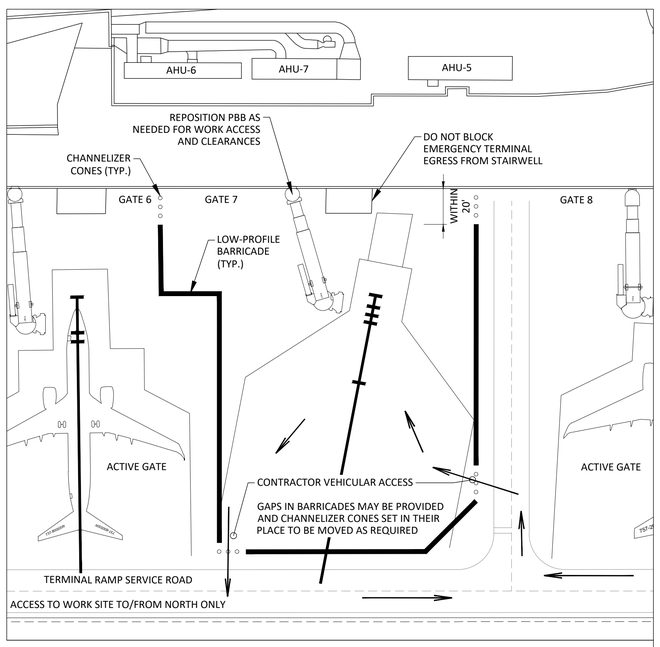
Bolton & Menk Inc. - H:\MANCHEST_CI_NH\26X\144256000\CAD\C3D\3 - Sheets\MTH_HVAC_SITE PLAN.dwg [GP-1 SITE PLAN] August 25, 2026 - 1:41pm [hailey.jones]

CONSTRUCTION SAFETY AND PHASING NOTES

1. THE CONTRACTOR SHALL SUBMIT A WRITTEN SAFETY PLAN COMPLIANCE DOCUMENT (SPCD) TO THE ENGINEER, CITY OF MANCHESTER-DEPARTMENT OF AVIATION FOR REVIEW AND APPROVAL PRIOR TO MOBILIZATION AND BEFORE ANY CONSTRUCTION IS ALLOWED TO BE PERFORMED. ANY DELAY IN THE ISSUANCE OF THE NOTICE TO PROCEED DUE TO THE FAILURE BY THE CONTRACTOR TO OBTAIN AN APPROVED SPCD WILL NOT BE GROUNDS FOR ANY CONTRACT TIME EXTENSION. THE CONTRACTOR SHALL BECOME KNOWLEDGEABLE OF THE REQUIREMENTS AND PROCEDURE OF THE FAA ADVISORY CIRCULAR NO. 150/5370-2G OR (CURRENT EDITION) "OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION" AND THE APPROVED "CONSTRUCTION SAFETY AND PHASING PLAN" (CSPP), AND INCORPORATE RELEVANT ITEMS INTO THE SPCD WHICH MUST MEET OR EXCEED THE PROJECT'S CSPP REQUIREMENTS. THE SPCD SHALL BE MODIFIED AND UPDATED AS REQUIRED THROUGHOUT THE PROJECT TO ADDRESS EACH PHASE AND/OR SUB PHASE AS WORK PROGRESSES. SOME, BUT NOT ALL OF THE ITEMS, TO BE ADDRESSED IN THE SPCD ARE AS FOLLOWS:
    a. IDENTIFICATION AND QUALIFICATIONS OF DEDICATED SAFETY & SECURITY POINT OF CONTACT.
    b. WORK SCHEDULING, COORDINATION, AND NOTIFICATION PROCEDURES OF CONSTRUCTION ACTIVITIES.
    c. AIRFIELD COMMUNICATIONS AND 24-HOUR EMERGENCY NOTIFICATION PROCEDURES.
    d. CONSTRUCTION OPERATIONS ADJACENT TO OR WITHIN SAFETY AREAS, OBJECT FREE AREAS, NAVAID CRITICAL AREAS, AND APPROACH SURFACES (I.E. GRADING, HAULING MATERIALS, ETC.).
    e. METHODS AND REQUIREMENTS FOR SEPARATING CONSTRUCTION AREAS FROM AIR OPERATIONS AREAS (AOA).
    f. PREVENTING INTERFERENCE WITH FAA NAVAID (ILS OR OTHER) CRITICAL AREAS.
    g. CONTROL OF FOREIGN OBJECT DEBRIS (FOD) AND DUST.
    h. CONSTRUCTION VEHICLE REQUIREMENTS, VEHICLE ESCORT PROCEDURES AND DRIVER TRAINING FOR AUTHORIZED DRIVERS.
    i. OPERATIONS WITHIN MOVEMENTS AND NON-MOVEMENT AREAS TO PREVENT RUNWAY INCURSIONS.
    j. CONTRACTOR ACCESS POINTS, VEHICLES CROSSING LOCATIONS, SECURITY FENCING AND GATES, AND EMPLOYEE SECURITY TRAINING.
    k. PROCEDURES, REQUIREMENTS, AND COORDINATION OF GATE CLOSURES, AND CONTRACTOR ACCESS NEEDS INCLUDING NOTICE TO AIRPORT COORDINATION.
    l. LIGHTED BARRICADE AND CHANNELIZER CONE PLACEMENT LOCATIONS, AND TEMPORARY CONSTRUCTION SIGN LOCATIONS.
    m. PROCEDURES FOR MANAGING HAZARDOUS MATERIALS.
    n. PROCEDURES FOR LOCATING & PROTECTING EXISTING UTILITIES.
2. THE CONTRACTOR SHALL PROVIDE A COMPETENT SAFETY PERSON (WHO ALSO COULD BE THE SUPERINTENDENT OR OTHER SUPERVISORY PERSON) FAMILIAR WITH AIRPORT SAFETY TO MONITOR CONSTRUCTION ACTIVITIES. THIS INDIVIDUAL WILL BE RESPONSIBLE FOR MONITORING CONSTRUCTION ACTIVITIES AND PERSONNEL TO ENSURE THAT THEY ADHERE TO THE SAFETY REQUIREMENTS ESTABLISHED BY THE CONTRACT DOCUMENTS, THE SPCD, THE REGULATIONS AND REQUIREMENTS OF THE AIRPORT, FAA, AND OTHER APPLICABLE AGENCIES.
3. THE CONTRACTOR SHALL PROVIDE A POINT OF CONTACT TO THE OWNER, RESIDENT PROJECT REPRESENTATIVE (RPR), AND ENGINEER WHO CAN BE CONTACTED AT ANY TIME THROUGHOUT THE COURSE OF THE CONTRACT. THIS INDIVIDUAL WILL BE CAPABLE OF COORDINATING AN IMMEDIATE RESPONSE TO CORRECT ANY CONSTRUCTION RELATED ACTIVITY THAT MAY ADVERSELY AFFECT THE OPERATIONAL SAFETY OF THE AIRPORT.
4. UPON RECEIPT OF APPROVAL FOR A CLOSURE AND BEFORE EQUIPMENT ENTERS THE AIRFIELD AND CONSTRUCTION COMMENCES, THE WORK AREA SHALL BE SECURED. LIGHTING EQUIPMENT, CHANNELIZER CONES AND SAFETY BARRICADES SHALL BE PLACES AND OPERATIONAL AS APPLICABLE. THE WORK AREA SHALL BE CLEARLY DELINEATED AND ALL SAFETY REQUIREMENTS SHALL BE APPROVED BY THE RPR PRIOR TO BEGINNING ANY WORK.
5. CONSTRUCTION SIGNS (I.E., "CONSTRUCTION TRAFFIC" WITH ARROWS, "NO UNAUTHORIZED VEHICLES BEYOND THIS POINT" OR OTHER STANDARD MANUAL OF UNIFORM TRAFFIC CONTROL DEVICE (MUTCD) SIGNS) SHALL BE LOCATED AT THE WORK AREA EGRESS/INGRESS POINTS. THERE SHALL BE NO SEPARATE PAYMENT FOR PROVIDING THESE SIGNS.
6. THE CONTRACTOR SHALL ENSURE THAT NO PAVEMENT LIPS, PAVEMENT EDGES, SIGN FOUNDATIONS, STRUCTURES OR OTHER APPURTENANCES EXCEED 3 INCHES WITHIN ACTIVE AIRCRAFT OPERATIONAL AREAS.
7. DAILY COORDINATION OF CONSTRUCTION ACTIVITIES SHALL BE HELD ON-SITE WITH THE RPR AND MANCHESTER AIRPORT OPERATIONS (MHT) TO CLEARLY IDENTIFY THE LIMITS OF WORK FOR THE DAY. THE CONTRACTOR SHALL NOT EXCEED THE LIMITS OF WORK WITHOUT APPROVAL FROM THE RPR.
8. THE CONTRACTOR SHALL BE PROVIDED AN ESCORT FROM MHT OPERATIONS TO GET TO AND FROM THE WORK AREAS WHEN INSIDE THE AOA. THE CONTRACTOR SHALL STAGE VEHICLES COMING INTO THE AOA AT THE GATE AND BE ESCORTED, WITH A MAXIMUM OF 3 VEHICLES IN CONVOY BEHIND THE ESCORT VEHICLE, TO THE WORK AREAS.
9. DURING NIGHT WORK (IF ALLOWED), ALL LIGHTING EQUIPMENT UTILIZED SHALL BE CONTROLLED TO PREVENT STRAY LIGHT. THE CONTRACTOR SHALL DIRECT ALL LIGHTING AWAY FROM ADJACENT NEIGHBORHOODS AND IN A MANNER THAT DOES NOT INTERFERE WITH THE AIR TRAFFIC CONTROL TOWER AND AIRCRAFT OPERATIONS. THE CONTRACTOR SHALL PREPARE A LIGHTING PLAN TO BE REVIEWED AND APPROVED BY THE RPR. THE RPR SHALL APPROVE THE LOCATION AND OPERATION OF ALL LIGHTING EQUIPMENT.
10. LANDSIDE WORK AREA CONSTRUCTION BARRICADES. TRAFFIC CONTROL DEVICES (CONES, BARRELS, ETC.), DIRECTIONAL AND WARNING SIGNS, AND OTHER RELATED APPURTENANCES AS REQUIRED FOR WORK AREAS CAPTURE AND TRAFFIC MAINTENANCE FOR THE PEDESTRIAN BRIDGE RTU REPLACEMENTS SHALL CONFORM TO THE CURRENT EDITION OF THE FHWA MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES (MUTCD).

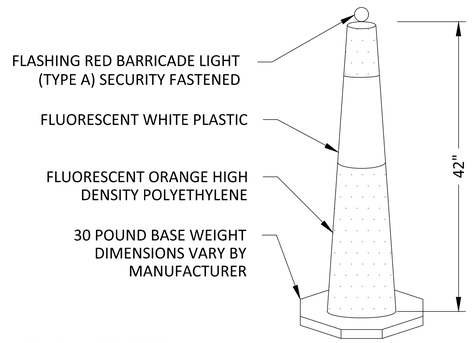
AVIATION BARRICADE NOTES

1. THE RPW AND MHT OPERATIONS WILL HAVE FINAL DETERMINATION WHERE EACH TYPE OF BARRICADE (LOW PROFILE, CHANNELIZED CONES, TRAFFIC CONES, ETC.) SHALL BE PLACED.
2. BARRICADES SHALL BE ONE OF THE BARRICADES SHOWN ON THIS SHEET OR APPROVED EQUAL.
3. ALL BARRICADES SHALL MEET THE REQUIREMENTS OF FAA ADVISORY CIRCULAR 150/5370-2G (CURRENT EDITION), "OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION".
4. THE CONTRACTOR SHALL SUPPLY ALL BARRICADES AS BEING INCIDENTAL TO THE OVERALL PROJECT. BARRICADES SHALL REMAIN THE PROPERTY OF THE CONTRACTOR AFTER PROJECT COMPLETION.
5. CONTRACTOR SHALL MAKE DAILY INSPECTIONS OF THE BARRICADES/CONES TO ENSURE LIGHTS ARE IN PROPER WORKING ORDER.



1 APPROX. GATE 7 CAPTURE PLAN (TO BE CONFIRMED BY CSPP)

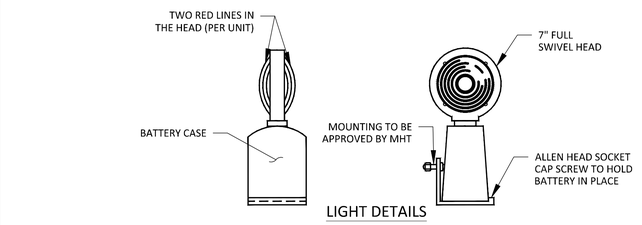
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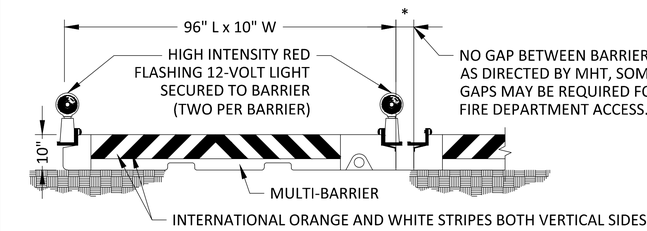
CHANNELIZER NOTES:
1. CHANNELIZER CONES SHALL BE SPACED 4' ON CENTER (MIN.) UNLESS OTHERWISE DIRECTED ON THE PLANS OR BY THE RPW.
2. CONES SHALL BE ADEQUATELY SECURED WITH WEIGHTED BASES OR APPROVED METHODS TO WITHSTAND HIGH WINDS AND/OR JET BLAST.

2 WORK ZONE LIGHTED CHANNELIZER CONE

NOT TO SCALE



LIGHT DETAILS



BARRICADE NOTES:
1. CONTRACTOR SHALL PROVIDE AN ADEQUATE NUMBER OF BARRICADES TO PROPERLY CLOSE AIRFIELD PAVEMENTS AS SHOWN ON THE SAFETY AND CAPTURE PLANS.
2. BARRICADES SHALL BE MULTI-BARRIER SAFETY BARRICADES WITH REFLECTIVE STRIPING.
3. BARRICADES SHALL BE PLACED END TO END TO CREATE A CONTINUOUS BARRIER.
4. BARRICADES SHALL BE ADEQUATELY WEIGHTED TO WITHSTAND HIGH WINDS AND/OR JET BLAST.
5. CONTRACTOR SHALL MAINTAIN FLASHING LIGHTS TO ENSURE PROPER WORKING ORDER THROUGHOUT THE DURATION OF THE PROJECT.
6. CONTRACTOR SHALL MOVE BARRICADES AT THE DIRECTION OF THE RPW OR MHT OPERATIONS.

3 WATER BALLASTED LIGHTED SAFETY BARRICADE

NOT TO SCALE

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PROJECT DESIGNER:

Manchester-Boston REGIONAL AIRPORT

SCALE: 1:1
DATE: 08/31/2026
DESIGNED BY: XX
DRAWN BY: XX
CHECKED BY: XX
APPROVED: XX

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION
AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26600028

GENERAL NOTES & ACCESS DETAILS

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

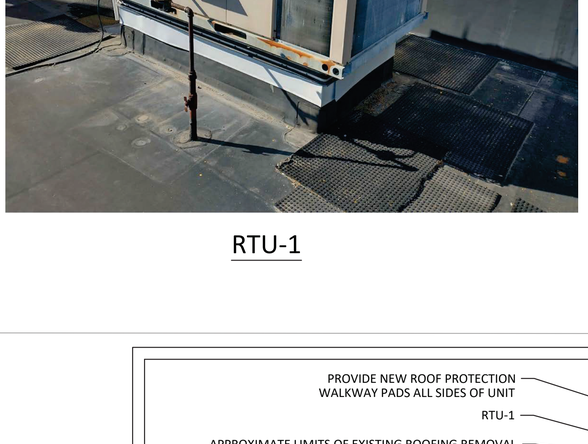
PROJ. NO.: 26X.144256
BMI FILE: xxx/xx
AIP NO.: 3-33-0011-TBD-2026

DRAWING NO.
GN-1
SHEET xx OF xx
REV xx

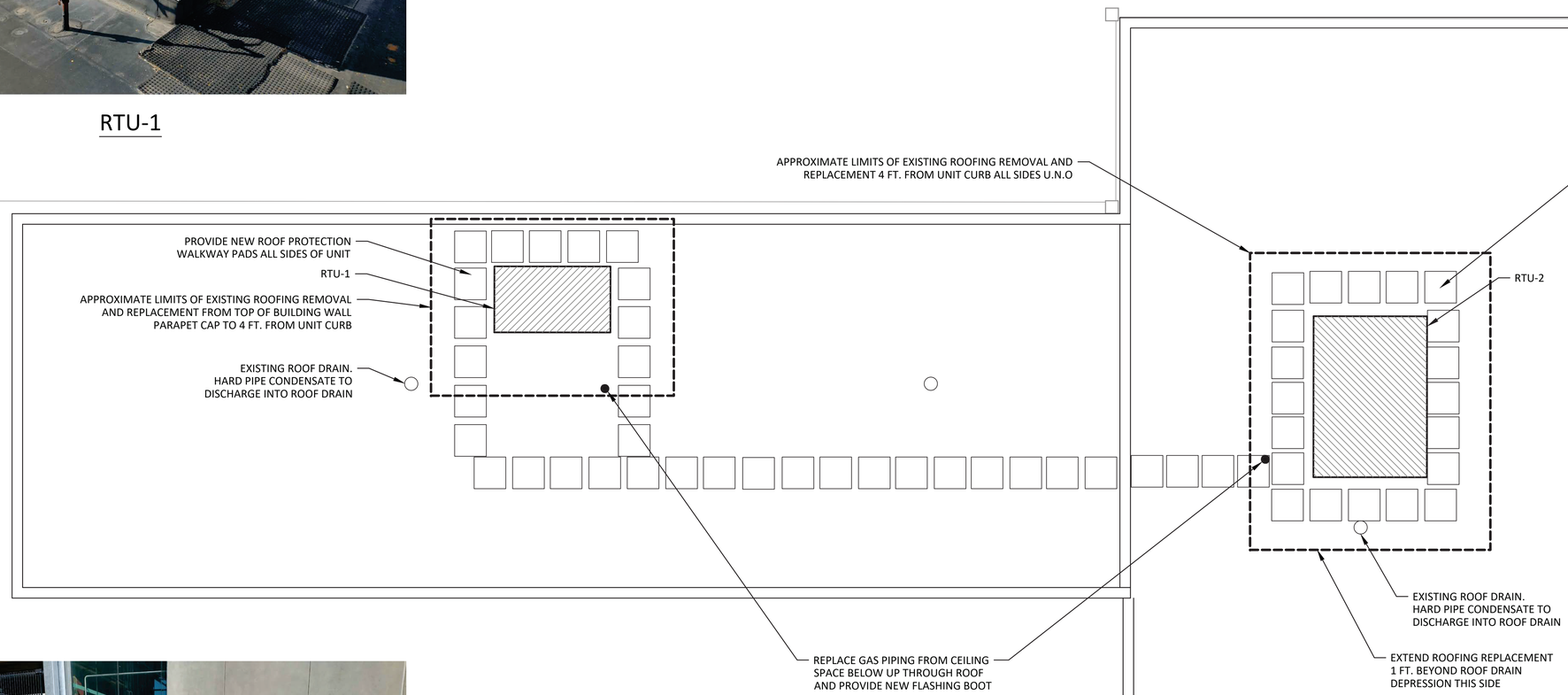
Bolton & Menk Inc. - H:\MANCHEST_CI_NH\26X144256000\CAD\C3D\3 - Sheets\MHT_HVAC_GEN NOTES & SHEETS.dwg [GN-1 GEN NOTES] August 18, 2026 - 10:41am [hailey.jones]



RTU-1



RTU-2



PROJECT DESIGNER:
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Manchester-Boston REGIONAL AIRPORT

SCALE: 1/4" = 1'-0"
DATE:
DESIGNED BY:
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APPROVED:

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

PROJECT NAME: AIRPORT TERMINAL AND WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26x.144256.000

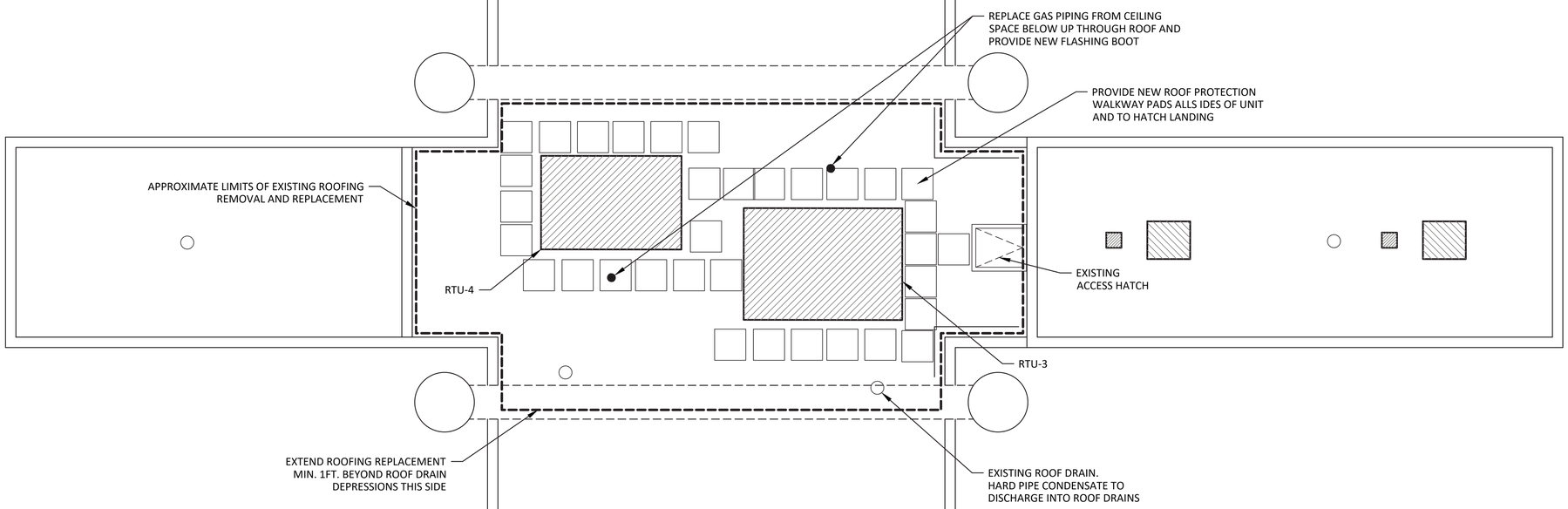
ENLARGED HVAC PLAN: RTU-1 & 2

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

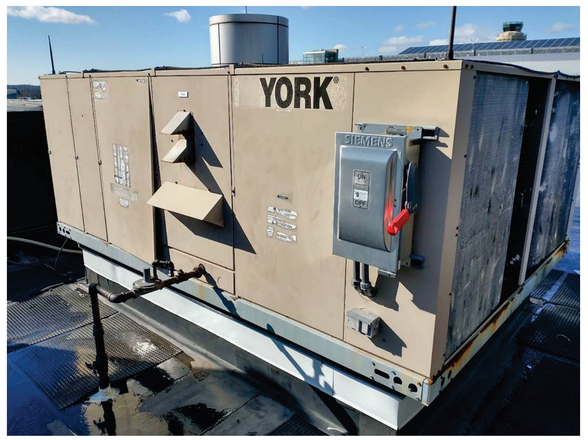
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BMI FILE: xxx/xx
AIP NO.: 0-00-0000-TBD-0000
DRAWING NO.
EP: RTU-1&2
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REV 0

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RTU-3



RTU-4

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DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED:

Manchester-Boston REGIONAL AIRPORT

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

PROJECT NAME: AIRPORT TERMINAL AND WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26x.144256.000

ENLARGED HVAC PLAN: RTU-3 & 4

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

PROJ. NO.: 26X.144256.000
BMI FILE: xxx/xx
AIP NO.: 0-00-0000-TBD-0000

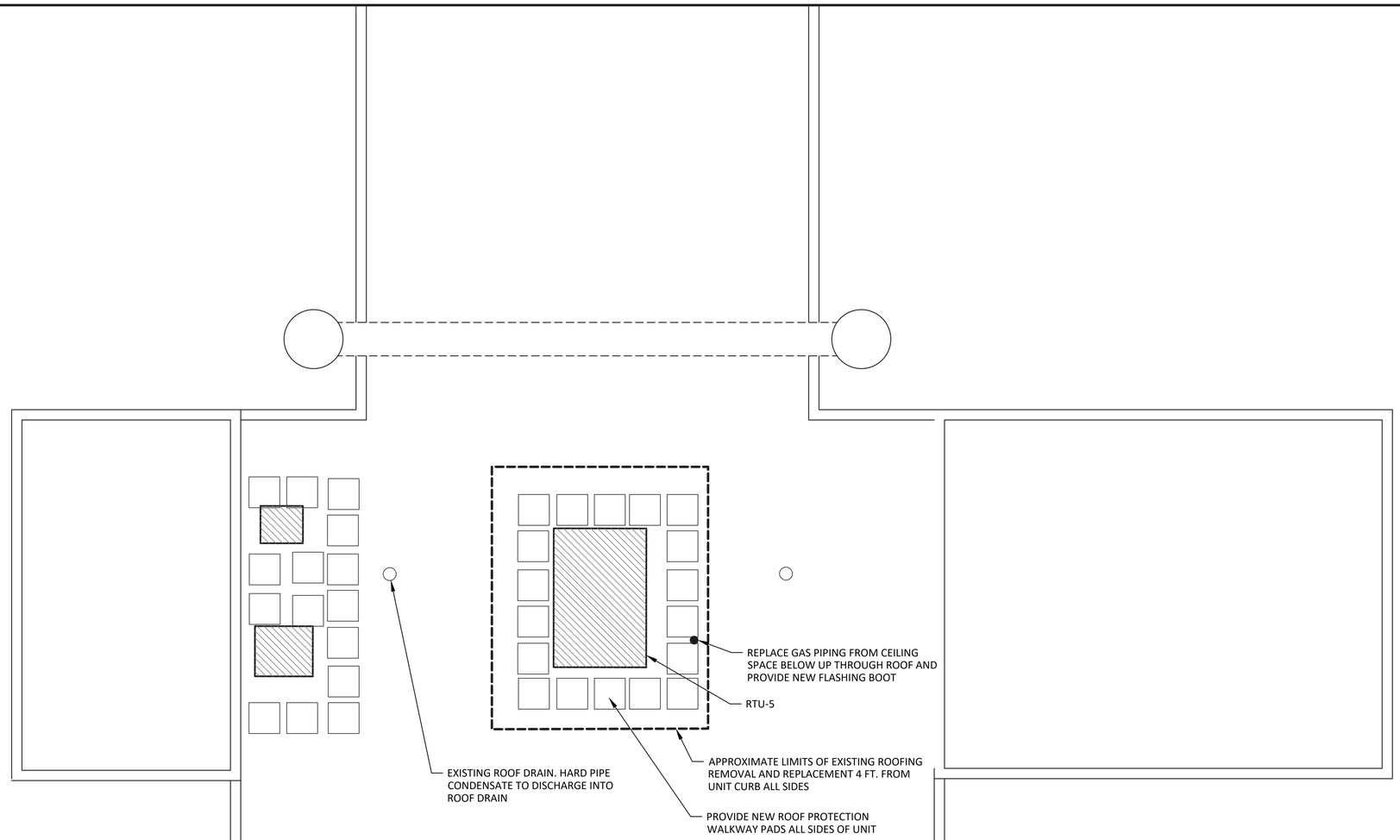
DRAWING NO.

EP: RTU-3&4

SHEET xx OF xx

REV 0

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RTU-5

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

PROJECT NAME: AIRPORT TERMINAL AND WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26x.144256.000

ENLARGED HVAC PLAN: RTU-5

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

PROJ. NO.: 26X.144256.000
BMI FILE: xxx/xx
AIP NO.: 0-00-0000-TBD-0000

DRAWING NO.

EP: RTU-5

SHEET xx OF xx

REV 0

PROJECT DESIGNER:

BOLTON & MENK

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DESIGNED BY:
DRAWN BY:
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APPROVED:

Manchester-Boston
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EXISTING ROOFING INSTALLED IN 1998 THIS AREA

EXISTING ROOFING INSTALLED IN 2015 THIS SIDE OF BUILDING

EXISTING BUILDING JOINT

APPROX. LOCATION OF EXISTING ROOF DRAIN. HARD PIPE CONDENSATE DISCHARGE INTO DRAIN

PROVIDE NEW WALK PADS TO EQUIPMENT ALL SIDES AND EXTENDING FROM EXISTING WALK PADS FROM AHU-3/4 AND TO AHU-7 AREA

APPROXIMATE LIMITS OF EXISTING ROOFING REMOVAL AND REPLACEMENT

ROOFING REPLACEMENT FOR LATER AHU-7 REPLACEMENT TO BE CONTINUOUS ONTO AHU-5 ROOFING REPLACEMENT

AHU-5

OVERLAP NEW ROOFING REPLACEMENT ONTO NEWER EXISTING ROOFING (PLACED IN 2025)



AHU-5

N

H

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Manchester-Boston REGIONAL AIRPORT

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MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

PROJECT NAME: AIRPORT TERMINAL AND WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26X.144256.000

ENLARGED HVAC PLAN: AHU-5

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

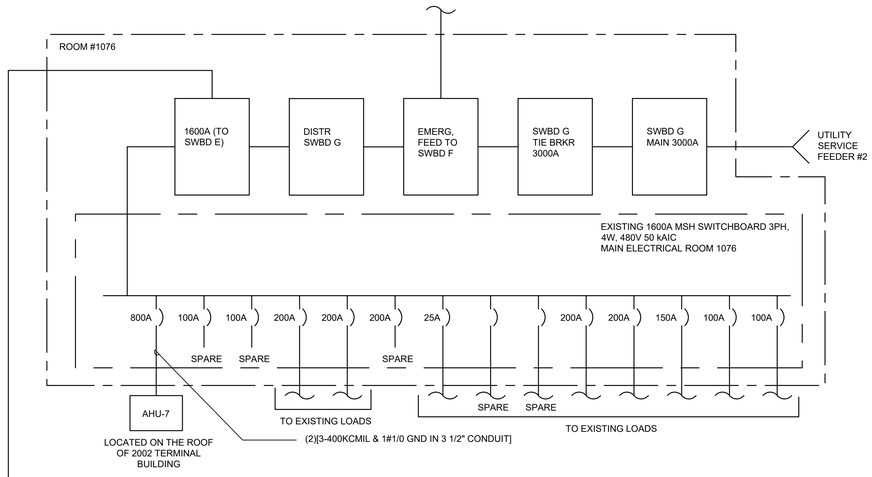
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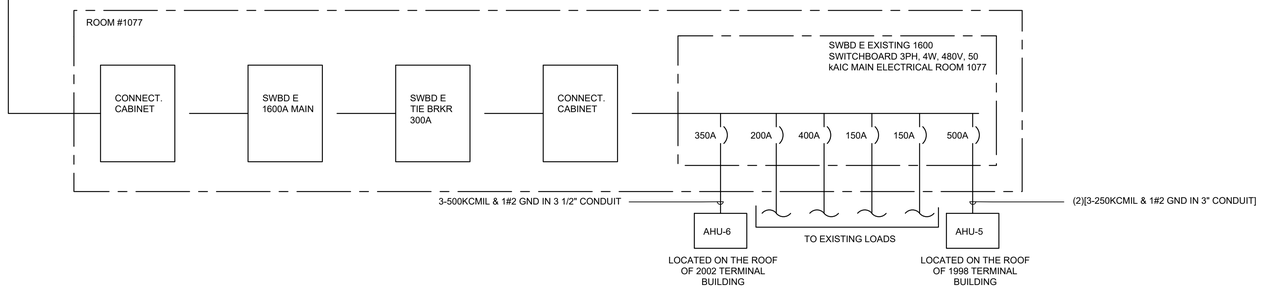
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Manchester·Boston REGIONAL AIRPORT

SCALE:	NTS
DATE:	AUG 2026
DESIGNED BY:	CF
DRAWN BY:	NM
CHECKED BY:	JP
APPROVED:	JG

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 26000228

SINGLE LINE DIAGRAM–AHUs

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

PROJ. NO.: 26X.144256
BMI FILE: xxx/xx
AIP NO.: 3-33-0011-TBD-2026

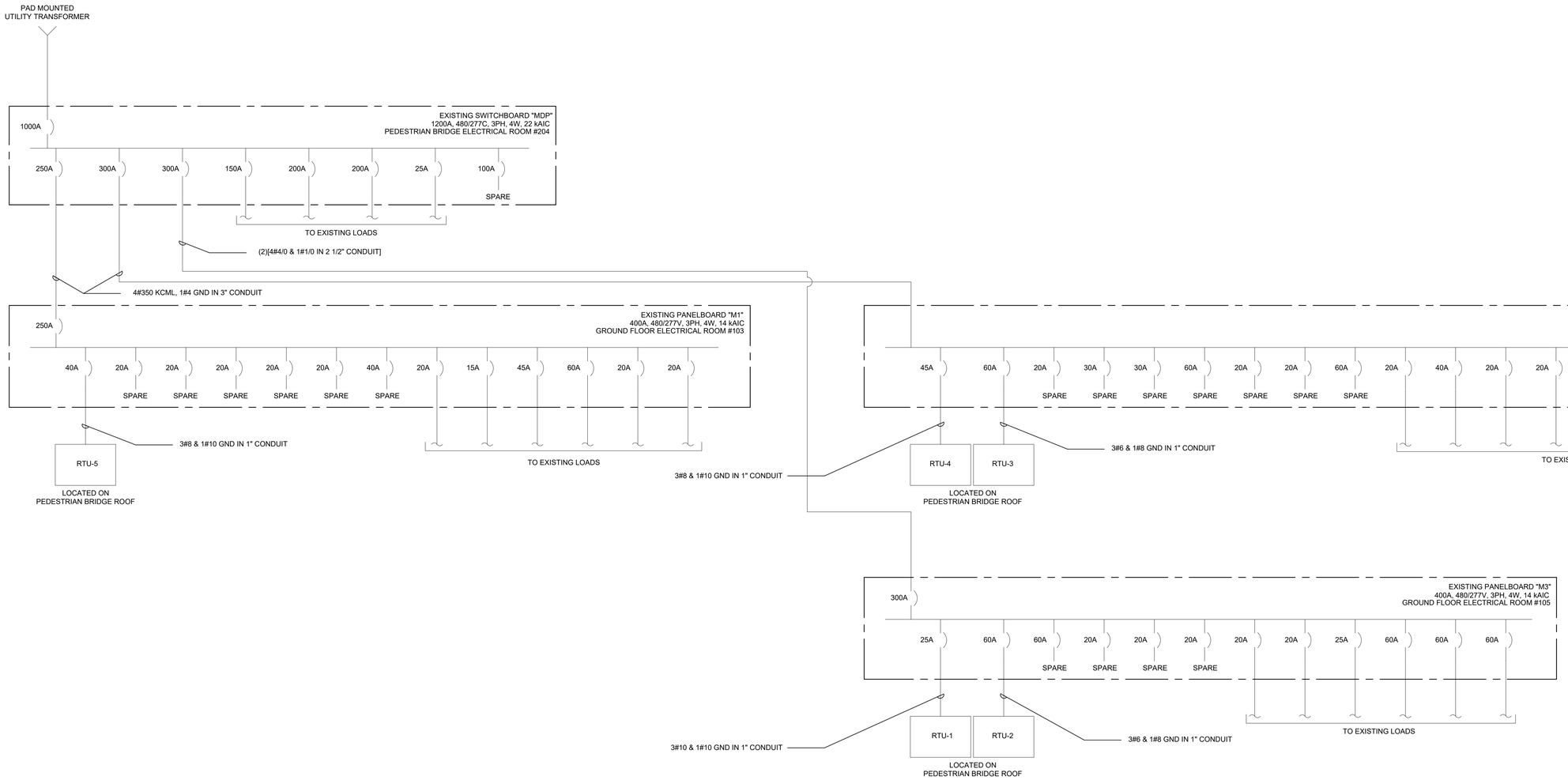
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E-1

SHEET 1 OF 2

REV 0

Bolton & Menk Inc. - \\mhtfil01\JOB\2026\E2XA5400 - MHT HVAC Replacement Project\700 CAD\Plans\MHT HVAC Oneline 20260824.dwg [E-1] August 24, 2026 - 5:00pm [pelletjp]



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PROJECT DESIGNER: BOLTON & MENK

Manchester-Boston REGIONAL AIRPORT

SCALE:	NTS
DATE:	AUG 2026
DESIGNED BY:	CF
DRAWN BY:	NM
CHECKED BY:	JP
APPROVED:	JG

MANCHESTER – BOSTON REGIONAL AIRPORT
CITY OF MANCHESTER, NH, DEPARTMENT OF AVIATION

AIRPORT TERMINAL & WALKWAY – HVAC EQUIPMENT REPLACEMENT
PROJECT NUMBER: 2600028

SINGLE LINE DIAGRAM–RTUs

REVISIONS

REV. NO.	DATE	DESCRIPTION	BY

PROJ. NO.: 26X.144256

BMI FILE: xxx/xx

AIP NO.: 3-33-0011-TBD-2026

DRAWING NO.

E–2

SHEET 2 OF 2

REV 0

Bolton & Menk Inc. - \\mhtfil01\JOB\2026\E2XA5400 - MHT HVAC Replacement Project\700 CAD\Plans\MHT HVAC Oneline 20260824.dwg [E-2] August 25, 2026 - 2:30pm [pelletjp]

ISOLATION VALVES FOR AHU-5 (IN CEILING SPACE)

CONNECT TO EXISTING ELEVATION TO BE VERIFIED IN FIELD

ISOLATION VALVES FOR AHU-5 EXPOSED OVERHEAD IN (EMPTY) FORMER BAG SCREENIG EQUIP ROOM # 1200 / BETWEEN TC4 AND TC3 - NO DRAINS ON PIPE

GREEN LINE ILLUSTRATES APPROX. EXTENTS OF DRAIN-DOWN FOR GLYCOL PPING

VERIFY - GLYCOL LINES CAPPED OFF

APPROX. LOCATION OF 4" DIA. VERTICAL GLYCOL PIPE RISERS UP TO AHU-5

AHU-5 AIR OPENINGS

APPROX. OUTLINE OF AHU-5 ON ROOF ABOVE

THIS STAIR DEMOLISHED BY 2002 EXPANSION

EXISTING WALLS ON GROUND FLOOR LEVEL

BAGGAGE TABLE / WORKSTATION - ON GROUND FLOOR - DIRECTLY BELOW GLYCOL LINES VERTICAL RISERS UP TO AHU-5. (MOVE TEMPORARILY FOR WORK)

TEMPORARY GLYCOL TANK - APPROX. LOCATION

TEMPORARY GLYCOL TANK - APPROX. LOCATION

AHU-5 LOW POINT DRAINS - IN TUG GARAGE ABOVE BAGGAGE CAROUSEL

ISOLATION VALVES FOR AHU-5 (EXPOSED AT CEILING HEIGHT)

DRAIN DOWN LOCATION FOR AHU-5. OWNER WILL PLACE TEMPORARY TOTE TANKS IN OUTBOUND BAGGAGE MAKE-UP ROOM (TUG GARAGE) FOR USE BY CONTRACTOR.

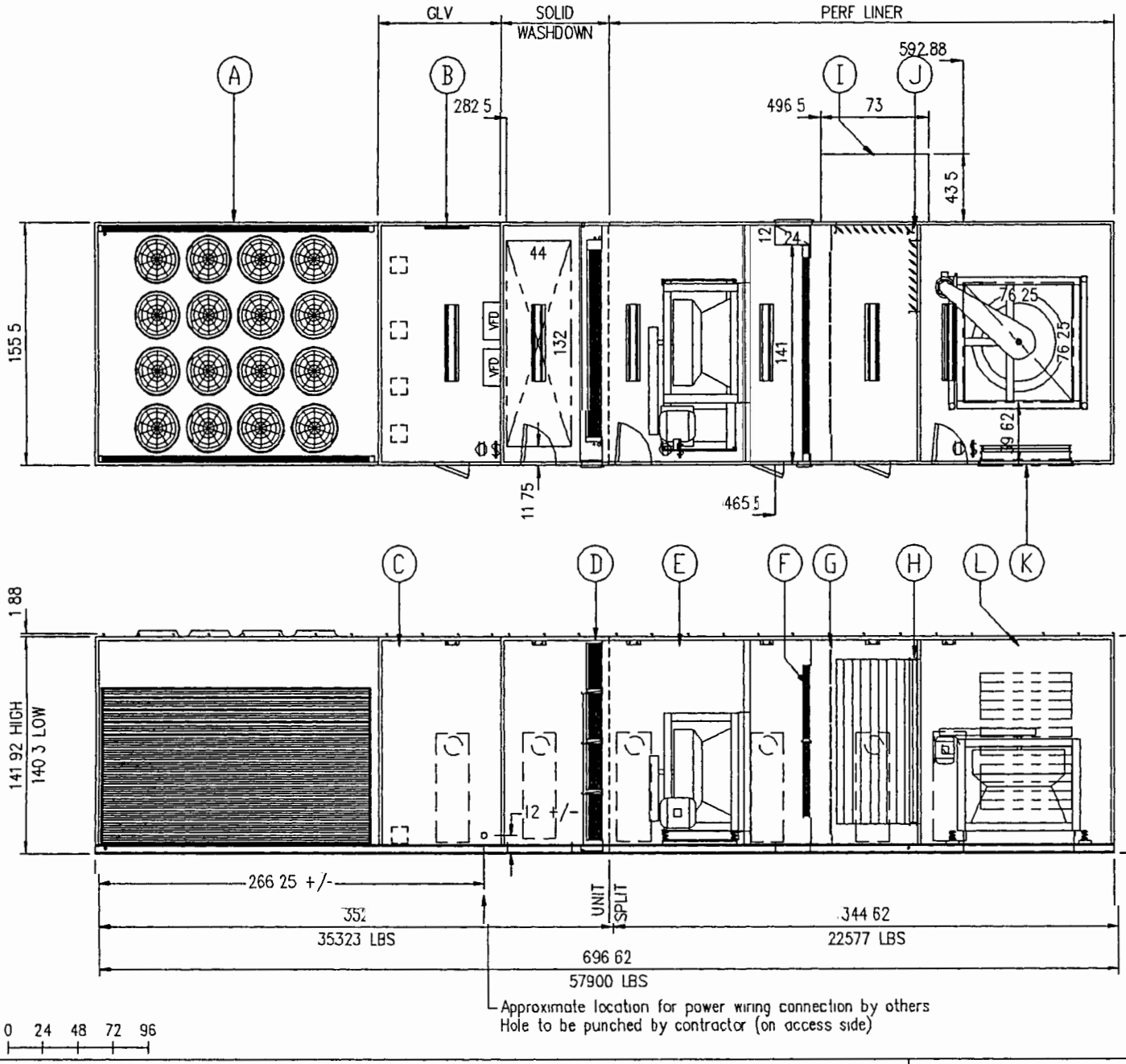
BOTH LINES REDUCE TO 2" AFTER VALVE AND CONTINUE

ISOLATION VALVES FOR AHU-5 IN TUG GARAGE (EXPOSED)

AIRPORT TERMINAL & WALKWAY - HVAC EQUIPMENT REPLACEMENT PROJECT:
SPECIFICATIONS SECTION 00 20 00 SCOPE OF WORK

ILLUSTRATIVE FIGURE-1
AHU-5 GLYCOL & DUCT

FIGURE-2: AHU-5 EQUIPMENT MANUFACTURER REFERNCE DATA (FIELD VERIFY AS REQUIRED)



(A) CONDENSING UNIT
CAPACITY 184 TONS No CIRCUITS 4
VOLTAGE 460/3/60

(B) 3000W BB Heater
- c/w Thermostat

(C) COMPRESSOR AND ELECT
C/W PROP FAN AND LOUVRE

(D) COOLING COIL
TYPE 6 ROW
SIZES 4 @ 30 X 120
CONN LEFT PULL RIGHT
DRAIN LEFT

(E) FAN (SF) 55" APF SW
Arrangement-3
AIR FLOW 50000 CFM RPM 775
T.S.P 4 47 in wc CLASS II
MOTOR 75 HP, ODP, Hi-Eff 460/3/60
RPM 1750
ISOLATORS OS DEF 2 in

(F) HEATING COIL
TYPE 2 ROW
SIZES 2 @ 48 X 125
CONN LEFT PULL RIGHT

(G) FILTERS LIFT-OUT UPSTREAM
VELOCITY 500 FPM
TYPE 2" Farr 30/30
SIZES 25 @ 24 X 24

(H) RA DAMPER PARALLEL BLADES
MAKE T.A. Morrison-1000
SIZE 108 X 48

(I) OA HOOD
TYPICAL OF 5

(J) OA DAMPER PARALLEL BLADES
MAKE T.A. Morrison-1000
SIZE 108 X 54

(K) EA DAMPER PARALLEL BLADES
MAKE T.A. Morrison-1000
SIZE 64 X 90

(L) FAN (RF) 63" APF SW,
Arrangement-3
AIR FLOW 45000 CFM RPM 441
T.S.P 1 7 in wc CLASS I
MOTOR 20 HP ODP Hi-Eff 460/3/60
RPM 1750
ISOLATORS OS DEF 2 in

UNIT MOUNTING
The unit is designed to be mounted on a roof curb

Note Calculated unit weights are shipping weights and do not reflect operating conditions

SDG NOTE Jan 19 1999

PROJECT MANCHESTER AIRPORT

OPENINGS AND DIMENSIONS MAY VARY FROM CONTRACT DOCUMENTS RETURN OF APPROVED DRAWINGS CONSTITUTES ACCEPTANCE OF THESE VARIANCES.

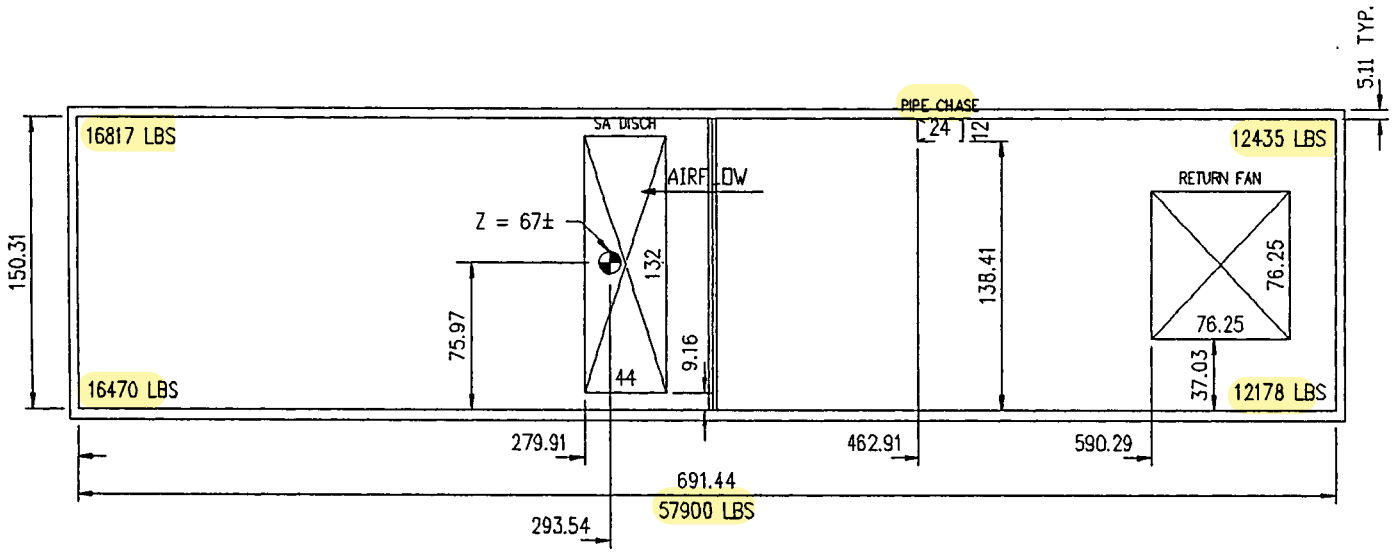
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TAG	AHU-5	REV	JAN 19/99	TYPE	OUTDOOR	15 29		SCALE	NTS

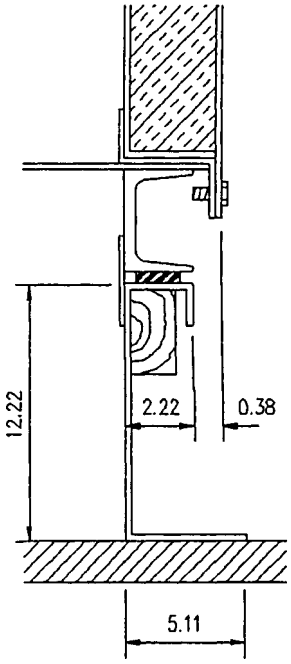
SALES OFFICE	HTS BOSTON
SALES ENGINEER	DAN SENESE

HAAKON INDUSTRIES
11100 RIVER ROAD RICHMOND BC CANADA V6X 1Z5

AHU-5 EQUIPMENT MANUFACTURER REFERNCE DATA (FIELD VERIFY AS REQUIRED)

ROOFCURB LAYOUT – outline is base of roofcurb





SECTION VIEW

0 24 48 72 96

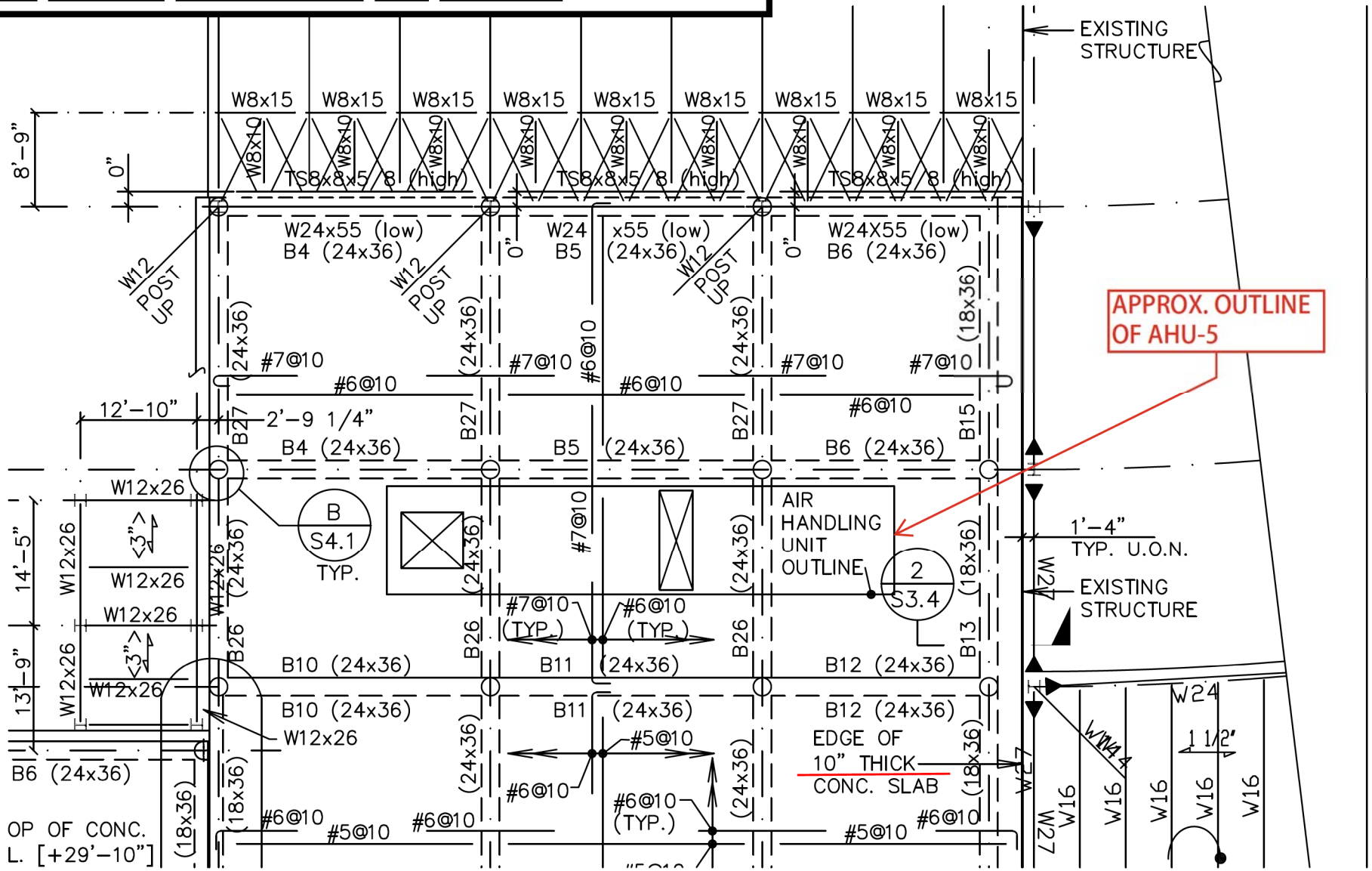
SDS VER. Jan. 19 1999

PROJECT	MANCHESTER AIRPORT								OPENINGS AND DIMENSIONS MAY VARY FROM CONTRACT DOCUMENTS RETURN OF APPROVED DRAWINGS CONSTITUTES ACCEPTANCE OF THESE VARIANCES.		HAAKON INDUSTRIES
JOB NO.	6135	DRAWN BY	HL	DWG NO.	6135FP03	ACCESS SIDE	RIGHT	DWG UNITS	IN	SALES OFFICE	HTS BOSTON
TAG	AHU-5	DATE	JAN 19/99	TYPE	OUTDOOR	15:37		SCALE	N.T.S.	SALES ENGINEER	DAN SENESE

11100 RIVER ROAD, RICHMOND, B.C. CANADA V6X 1Z5

AIRPORT TERMINAL & WALKWAY - HVAC REPLACEMENT PROJECT:
SPECIFICATIONS SECTION 00 20 00 SCOPE OF WORK

ILLUSTRATIVE FIGURE-3A
1998 ROOF FRAMING AT AHU-5



SEE ILLUSTRATIVE FIGURE-3B FOR CONC. ROOF BEAMS SCHEDULE

AIRPORT TERMINAL & WALKWAY - HVAC REPLACEMENT PROJECT:
PECIFICATIONS SECTION 00 20 00 SCOPE OF WORK

BEAM SCHEDULE

ILLUSTRATIVE FIGURE-3B 1998 ROOF BEAMS SCHEDULE

BEAM No.	SIZE (BxD)	STIRRUPS	BEAM REINFORCING
B1	18"x36"	10–#4@8" E.E. REMAINING #4@12"	2–#8T, 2–#8T, 2–#8T, 2–#8B, 2–#8B
B2	18"x36"	10–#4@8" E.E. REMAINING #4@12"	2–#8T, 2–#8T, 2–#8T, 2–#8B, 2–#8B
B3	18"x36"	10–#4@8" E.E. REMAINING #4@12"	2–#8T, 2–#8T, 2–#8B, 2–#8B
B4	24"x36"	14–#4@8" E.E. REMAINING #4@12"	3–#10T, 2–#10T, 3–#10T, 3–#9B, 2–#9B
B5	24"x36"	14–#4@8" E.E. REMAINING #4@12"	2–#10T, 3–#10T, 2–#10T, 3–#9B, 2–#9B
B6	24"x36"	14–#4@8" E.E. REMAINING #4@12"	3–#10T, 2–#10T, 3–#9B, 2–#9B
B26	24"x36"	18–#4@6" REMAINING #4@12"	3–#10T, 2–#10T, 3–#10T, 3–#9B, 2–#9B
B10	24"x36"	10–#4@8" E.E. REMAINING #4@12"	3–#8T, 2–#8T, 3–#8T, 3–#8B, 2–#8B
B11	24"x36"	10–#4@8" E.E. REMAINING #4@12"	2–#8T, 3–#8T, 3–#8B, 2–#8B
B12	24"x36"	10–#4@8" E.E. REMAINING #4@12"	3–#8T, 2–#8T, 3–#8B, 2–#8B
B13	18"x36"	10–#4@8" E.E. REMAINING #4@12"	2–#9T, 2–#9T, 2–#9T, 2–#7B, 2–#7B

℄ SUPPORT "E" LAP (TYP.) ℄ SUPPORT

Manchester- Boston Regional Airport
HVAC Load Calculation Draft Memorandum

August 14, 2009

Introduction:

The HVAC system of the passenger terminal building is unable to maintain the cooling set point frequently during the summer. Cosentini Associates have calculated the cooling and heating load for the building and compared that to the existing design conditions to determine if there is a lack of cooling capacity in localized areas and/or systematically throughout the building. The comparison between the calculated cooling load capacity and actual capacity will be used to determine where, and to what extent, heat gains need to be reduced so as to reduce cooling loads. Potential cooling load reduction strategies will be developed in the next phase of the project and documented in the Longer-Term Energy Conservation Measures Memorandum.

Load Calculation:

The cooling and heating loads were calculated using Trane Trace 700 software (version 6.1). This is one of the standard software programs for calculating cooling and heating loads.

The software program calculates the peak cooling and heating loads for each zone by modeling the heat transfer:

- Through the building envelope (heat gain/loss and solar gain through windows)
- From internal heat gains (lights, appliances such as computers, x-ray machines, cooking equipment, and from people). The appliance loads are estimated on a power density basis (Watts/ Square foot) for each type of space.
- From ventilation loads (energy required to cool or heat the outside air).

Building envelope information has been taken from as-built drawings, specifications, and shop drawings. The lighting loads have been calculated for each type of space (office, lobby, holding area, restroom, etc.). The heat generated by people and population density is based on guidelines from the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

Explanation of Calculations and Comparison to Existing Design:

There are essentially two main components that are being analyzed for capacity- the rooftop units and the terminal units. The cooling for the passenger terminal building is ultimately accomplished in the rooftop units. Outside air (for ventilation) and return air is mixed in the rooftop unit and cooled by direct expansion (DX) coils inside the unit. A fan in the rooftop unit blows this cooled air through the ductwork to the terminal units. The cooling capacity required by the DX coils as calculated has been compared to the capacity of the installed DX coils. The terminal units are the Variable Air Volume (VAV) boxes that modulate the amount of cooling air to individual spaces or areas inside the terminal building. Comparison between the capacity of the terminal units and the calculated cooling loads determines the adequacy of the cooling for individual spaces.

Capacity of the Rooftop Units

The capacity of the rooftop units is the rate at which heat can be removed from the air and is expressed in cooling tonnage and Btu's per hour (Btu/h), where 1 cooling ton is equivalent to 12,000 Btu/ h. The capacity is split into three categories:

- Sensible Cooling Capacity: This is the amount of heat that is removed due to simply reducing the temperature of the air, which will result in a reduction in dry bulb temperature only.
- Latent Cooling Capacity: This is the amount of cooling capacity required to remove moisture from the air, which reduces the wet-bulb temperature (and relative humidity). The cooling coil needs to be below the dew point of the air to remove any moisture from the air. Cooling coils are typically designed and operated to cool the air to around 55F in order to keep the humidity level in the space at a comfortable level.
- Total Cooling Capacity: This is the sum of the sensible and latent cooling capacities.

The rooftop units are each cooled with multiple refrigerant circuits. The cooling is done through an evaporator coil in the unit. Air is returned from the space, mixed with an appropriate amount of outside air, and then the air is blown by a fan through the evaporator coil where it is cooled to the supply air temperature and ducted to the terminal units.

The amount of cooling the rooftop units need to do is based on the amount of outside air (required for ventilation), the design conditions of the outside air (dry bulb and wet bulb temperatures), the conditions of the return air (dry bulb and wet bulb temperatures) and the amount of supply air and its condition (dry bulb and wet bulb temperatures).

The amount of outside air is based on the number of people in the area served by the unit and the amount of air required by each person. The air requirement per person is set forth in ASHRAE standard 62.

There are multiple outdoor summer design conditions for each geographic location. They are referred to as the 0.4 percent, 1 percent, and 2 percent conditions. For example, the 1 percent condition is a statistical value which means that the outdoor temperature should on average be above this number 1 percent of the year. As the percentage increases, the design temperature will naturally be lower. The energy code for New Hampshire is based on the International Energy Conservation Code (IECC) 2006. The code stipulates that Hillsborough County (where Manchester-Boston Regional Airport is located) is in Climate Zone 5A. The 1 percent design conditions for Manchester, NH are used for the calculations.

Capacity of the Terminal Units

The cooling capacity of each terminal unit (VAV Box or fan-powered VAV box) is determined based on the supply air temperature, room design temperature (the temperature at which the room is to be maintained), and air quantity (measured in cubic feet per minute (cfm)). The cooling capacity is determined from the formula:

Capacity (Btuh) = 1.08 * Airflow *(T design-T supply)

Typically, air handling units (AHU) are designed to discharge supply air at approximately 55F for VAV systems for cooling. Discharging air at this temperature allows for proper dehumidification. The design cooling temperature is assumed to be 75F. The design supply temperatures used for the calculations are based on the actual design supply temperatures, which are in the range of 57F.

The capacity of the terminal units should meet or exceed the cooling load (amount of heat generated or transferred into the space). Using a design temperature of 75F and the same

supply temperature in the calculations that the units are designed to discharge, the actual airflow of the VAV box should meet or exceed the calculated airflow required.

Explanation of Calculations and Comparison to Existing Design:

In order to evaluate the cooling capacity of the AHUs the sensible cooling capacity, total cooling capacity and supply air flow of installed AHUs was compared to the required sensible cooling capacity, total cooling capacity and supply air flow calculated by Trace 700 software. The results of this evaluation are provided in Appendix A and summarized in the following sections.

Roof Top Units

1. **Rooftop Unit: AHU-1**

AHU-1 serves the following spaces:

- north side of the upper lobby (2-40b, 2-41b)
- security check (2-46)
- news/gift space (2-51)
- restaurant (2-42b)
- kitchen (2-55)
- conference center (2-52 through 2-54)
- east departure lounges (2-59 through 2-65)
- east section of the third floor (3-14, 3-20 through 3-26)
- observation area and court area at third level (3-10, 3-28)

The calculations show that the installed capacity of AHU-1 is adequate to meet the calculated peak cooling load, with some capacity to spare. Calculated and installed total capacity, sensible capacity, and the amount of supply air differ by 2.5 percent, 12.2 percent and 7.1 percent, respectively (Appendix A, Table 1).

2. **Rooftop Unit: AHU-2**

AHU-2 serves the following spaces:

- large lobby space located on the left side from the entrance lobby including auto rental area, limousine service area, and baggage claim (1-148 through 1-152)
- three stairs located on the east side of the building (2-71 through 2-73)
- operation area (1-175 through 1-189)

The calculations show that the installed capacity of AHU-2 is adequate to meet the calculated peak cooling load, with capacity to spare. Calculated and installed total capacity, sensible capacity, and amount of supply air differ by 24.4 percent, 29.7 percent and 21.2 percent, respectively (Appendix A, Table 2). The large difference in installed and calculated peak cooling load is most likely caused by the addition of Blast Guard tint film after the passenger terminal building was constructed. The Blast Guard tint film installed on the glazing on the front façade has reduced solar heat gain to the lobby space of the terminal and lowered the required cooling capacity.

3. **Rooftop Unit: AHU-3**

AHU-3 serves the following spaces:

- south side of the upper lobby (2-40a, 2-41a)
- food court (2-42a, 2-37, 2-38)

- fast food (2-33, 2-34, 2-36)
- section of south departure lounge (2-26 through 2-31)
- west section of the third floor (3-01 through 3-05, 3-11 through 3-13, 3-15)
- upper lobby at third level immediately below the skylight (3-040)

The calculations show that the installed capacity of AHU-3 is adequate to meet the calculated peak cooling load, with some capacity to spare. Calculated and installed total capacity, sensible capacity, and amount of supply air differ by 4.5 percent, 15.7 percent and 9.1 percent, respectively (Appendix A, Table 3).

4. Rooftop Unit: AHU-4

AHU-4 serves the following spaces:

- large ticket lobby space located on the right side from the entrance lobby including Southwest, Independence and US Airways ticket counters (1-32, 1-33)
- stair/escalator (1-35)
- offices and restrooms (1-135a through 1-142, 1-135b through 1-146)
- baggage equipment area (1-109b,1-110)
- office space located between counters and baggage equipment (1-100 through1-108, 1-112 through 1-129)

The installed capacity of AHU-4 is adequate to meet the calculated peak cooling load, with capacity to spare. As for AHU-2, this unit has total cooling capacity, sensible cooling capacity and supply air flow that exceed the minimum requirements at peak load by 22.7 percent, 26.2 percent, and 13.6 percent, respectively (Appendix A, Table 4). The large difference in installed and calculated peak cooling load is most likely caused by the addition of Blast Guard tint film on the glass on front façade curtain wall which resulted in reduced solar heat gain to the lobby space.

5. Rooftop Unit: AHU-5

AHU-5 serves the following spaces:

- ticket lobby including Delta and Comair ticket counters (1-31)
- baggage equipment area (1-109a)
- office space located between the ticket counters and baggage equipment area (1-083 through 1-099)
- outbound baggage (1-81, 1-82, 1-130)
- section of south departure lounge (2-016, 2-017, 2-019, 2-020 through 2-025)
- stair at the second floor (2-026b)

The calculations show that the installed capacity of AHU-5 is adequate to meet the peak cooling load, with capacity to spare. The calculated and installed total capacity, sensible capacity, and amount of supply air differ by 49.7 percent, 42.3 percent and 37.1 percent, respectively (Appendix A, Table 5). Reconstruction of the lobby extension in 2002 contributed to the reduced cooling capacity for two reasons: a section of the space originally served by system AHU-5 was assigned to system AHU-6&7, reducing the cooling load on AHU-5, and the stair exterior walls were converted to interior walls, eliminating the heat gain through those walls.

6. Rooftop Unit: AHU-6&7

AHU-6&7 serves the following spaces:

- ticket lobby (1-29, 1-30)
- security check area (1-28a, 1-28b)

- baggage claim (1-025a, 1-025b, 1-026, 2-027)
- connector (1-34, 1-35, 2-14c)
- offices located between lobby and baggage equipment area (full list of spaces provided in Appendix A, Table 6a)
- office space located on west side of the building extension and below the large holding room (full list of spaces provided in Appendix A, Table 6a)
- large holding room (2-01 through 2-06)

The calculations showed that the installed capacities of AHU-6&7 are adequate to meet the calculated peak cooling load. Calculated and installed total capacity, sensible capacity, and amount of supply air differ by 1.6 percent, -3.1 percent and -0.6 percent, respectively (Appendix A, Table 6). The difference of -3.1 percent means that the installed sensible cooling capacity is slightly lower than the calculated cooling load for this unit. However, this difference is not significant and the unit will perform satisfactorily.

7. Rooftop Unit: RTU-1

RTU-1 serves the stair tower. The calculations show that the installed capacity of RTU-1 is adequate to meet the calculated peak load, with capacity to spare. Calculated and installed total capacity, sensible capacity, and amount of supply air differ by 42 percent, 56 percent and 27 percent, respectively (Appendix A, Table 7).

8. Rooftop Unit: RTU-2, RTU-3, RTU-4

RTU-2, RTU-3 and RTU-4 serve the bridge area. Units RTU-2, RTU-3, and RTU-4 have sufficient total cooling capacity and sensible capacity to meet the peak load of the bridge area. Calculated and installed total capacity, sensible capacity, and amount of supply air differ by 9 percent, 13 percent and -4 percent, respectively (Appendix A, Table 6). A comparison of required and installed total capacity, sensible capacity, and amount of supply air is provided in Appendix A, Table 7.

9. Rooftop Unit: RTU-5

RTU-5 serves the lobby and escalator below the bridge. Design cooling capacity, sensible capacity and amount of supply air flow of existing RTU-5 are lower by 20 percent, 19 percent and 32 percent compared to calculated required minimum capacity (Appendix A, Table 7). The units does not have sufficient capacity to provide design condition of 75 F under assumption that peak occupancy is 150 sf/person.

Terminal Units

In order to evaluate the cooling capacity of the terminal units, Cosentini Associates compared the quantity of supply air on shop drawings and as built drawings to the amount of supply air calculated by Trace 700 software. Brief summary for each zone is provided below. The results of this evaluation are provided in Appendix A and summarized in the following sections.

1. Lobby

The large lobby space was divided into five zones:

- Lobby 1: perimeter lobby space located on the right side of the entrance lobby including auto rental and baggage claim (1-148), auto rental and limo service (1-149, 1-150), and interior baggage claim area located in the south section of the building (1-151, 1-152)
- Lobby 2: entrance lobby (1-147)

- Lobby 3: lobby space located on the right side of the entrance lobby including Southwest, Independence and US Airways ticket counters (1-32, 1-33),
- Lobby 4: ticket lobby including United, Delta and Comair ticket counters (1-31)
- Lobby 5: ticket counter and lobby space next to the screening area (1-29, 1-30)

The installed capacity of the perimeter terminal units in lobby 1 is lower than the calculated capacity by about 28.7 thousand Btu per hour (MBH), while the capacity of the interior units in the same area exceeds the calculated capacity by 10.7 MBH. Overall, the total design cooling capacity of the terminal units serving lobby 1 was slightly deficient by 18.0 MBH in meeting the peak load. The installed capacities of terminal units serving lobby 3 is also lower, by 89.5 MBH, than the calculated capacity. However, the units serving lobby 4 and lobby 5 have sufficient capacity to meet peak load (Appendix A, Table 8). As the calculated load assumes peak solar gain and maximum occupancy, the terminal units are expected to perform with significantly smaller deficiency at average solar heat gain. The major deficiency in the achieved thermal comfort is in the lobby 2 (entrance lobby) due to lack of direct supply of cold air. The supply air intended to condition the entrance lobby is delivered through the stair space and from the upper lobby but it is questionable whether the supply air can reach the entrance lobby and provide satisfactory comfort.

The lobby area and baggage claim have a lighting power density of 1.53 W/SF and 0.9 W/SF, respectively. The lighting power density for lobby space is somewhat higher compared to present ASHRAE lighting allowances. ASHRAE Standard 90.1-2004 recommends lighting power densities of 1.5 W/S.F. for ticket counters and 0.6 W/S.F. for the airport concourse. The lighting power density for the baggage area is in a good agreement with ASHRAE standard recommendation (1.0 W/S.F.)

A reduction in heat gain can be achieved by reducing lighting load through utilization of daylight control. Simplified calculation showed that reducing the lighting power density in perimeter zones down to the density recommended in the ASHRAE Standard 90.1-2004 for airport concourse can yield a reduction in heating load by:

- 11.3 MBH in Lobby 1
- 1.8 MBH in the main entrance
- 7.3 MBH, 7.0 MBH, and 7.6 MBH in lobby 3, Lobby 4 and lobby 5 respectively.

Calculations of estimated reduction in lighting load are provided in Appendix A, Table 9.

2. Baggage Claim

Baggage claim covers a large floor area in the west section of the building extension, i.e. zones 1-26, 1-25a, 1-25b and 1-27. The installed capacity of the perimeter terminal units is lower than the calculated capacity by about 11.9 thousand Btu per hour (MBH), while the capacity of the interior units in the same area exceeds the calculated capacity by 7.7 MBH. Overall, the total design cooling capacity of the terminal units serving lobby baggage claim was slightly deficient by 4.2 MBH in meeting the peak load. The lighting power density in baggage claim area, at average 0.76 W/S.F., is below the recommended value by ASHRAE Standard which is 1 W/S.F.

Departure Lounges and Holdroom

The departure lounge was divided into four zones:

- Lounge 1: East departure lounge (2-59 through 2-65)
- Lounge 2: South departure lounge of the building section built in 1992 (2-26 through 2-31)
- Lounge 3: South departure lounge of the building section built in 1998 (2-16a, 2-17, 2-19, 2-24)

- Holdroom (2-01 through 2-06)

The design cooling capacity of the installed terminal units serving lounge 1, lounge 3 and a large holdroom providing access to gates 1 through 4 is greater that the cooling load calculated, while the terminal unit capacity serving lounge 2 is slightly lower. However, because Lounge 2 and lounge 3 comprise one big open space, the capacity of terminal units is adequate for the calculated peak cooling load. However, it was observed that the quantity of design supply air varies throughout the departure lounges, with the maximum quantity occurring in the mid section of each zone. This may result in some temperature variation within the space. The estimated reduction in heat gain due to reduction in lighting load in the daylight zones within holdroom area is 7.4 MBH. This value was calculated under assumption that daylight can replace 0.6 W/S.F. of installed lighting power. More accurate calculations will be provided in analysis performed using e-quest software 3-63.

3. Security Check

Terminal units serving security check areas (1-28a and 1-28b) located in the central section of the passenger terminal building extension have design cooling capacity that is not sufficient to meet the calculated peak load (Appendix A, Table 8). Because the largest component of the cooling load is due to occupancy, the thermal condition may vary significantly with number of people present in these areas. Deficiency in supply air of 29 percent and 25 percent at peak load (expressed in energy units of 30 MBH and 6.5 MBH) for security check areas 1-28a and 1-28b, respectively, was calculated under the assumption that large and small security areas are occupied by 167 and 45 people, respectively.

4. Connector with Bar

This two story zone consists of a corridor (1-35) and set of stairs (1-34) on the first level, and a bar (2-14c) on the second level. Installed cooling capacity in this area is less than the calculated cooling load by 27 percent, or expressed in energy units, is deficient by about 112.5 MBH (Appendix A, Table 8). Reduction of lighting load in this area will not significantly contribute to the required cooling capacity reduction.

5. Upper Lobby Area

The upper lobby was divided into two thermal zones:

- Upper lobby 1: entrance area below a large skylight (2-40b and 2-40a)
- Upper lobby 2: upper lobby space located between gift/news area and concessions (2-41a and 2-41b)

The terminal units serving upper lobby 1 have sufficient capacity to meet peak load in this area and to partly cover the heat gain experienced by the entrance lobby (Appendix A, Table 8).

6. Court and Observation Area

The court area was divided into three zones:

- Court 1: common court area at second floor (2-43a and 2-43b)
- Court 2: two separate security check areas individually served by systems AHU-1 and AHU-3 (2-45 and 2-46)
- Observation area including walkways at the third floor (3-10, 3-28 and 3-29)

The court space is conditioned at two levels: 1) supply air is delivered at the second floor, right at the entrance to security areas; 2) supply air is delivered above the walkways at the third level. The amount of supply air delivered at the second floor is sufficient to cover the heat gain

generated by occupancy and miscellaneous load. The supply air delivered at the third level is sufficient to cover heat gain through the walls, solar heat gain from vision glass, the load from lighting and partially the solar heat gain from the skylights. Overall, this two story space lacks cooling capacity of 130 MBH (Appendix A, Table 8). Air stratification with temperature gradient is likely to occur due to significant floor to ceiling height in this area. The highest temperature will occur immediately below the ceiling and gradually decrease as we approach the floor.

7. Third Floor Offices

All perimeter offices located on the third floor are served by terminal units with design cooling capacity that is lower than the required capacities. Deficiency in cooling capacity in perimeter spaces is about 43.1 MBH. Average lighting power density at the third floor is relatively high, with an average of 1.9 W/S.F. Reducing the lighting power density to 1.1 W/S.F. would reduce the required cooling capacity by 8.2 MBH. The benefit of interior shading devices were not considered in the calculations.

8. Restaurant/Fast Food Area/Conference Center

Shop drawings and as-built drawings do not document the actual amount of supply air that is delivered to several areas located on the second floor in the court area. The HVAC design had provided capped duct connection for later installation of terminal units as those spaces were fitted out. For that reason, the analysis for the restaurant, fast food area, conference center, and a couple other smaller spaces was performed assuming the design cooling capacity matches the capacity of the capped duct connections in those areas. All these areas have the capacity to receive a sufficient amount of supply air, except for the fast food space that lacks cooling capacity of 7 MBH.

Summary:

- The stated design capacities of the rooftop units have adequate capacity to meet the cooling load. However, based on the previous examination of the performance of the HVAC system (documented in the July 7, 2009 memorandum entitled *Summary of Air Handling Unit Controls Memorandum*), it appears that the system is not operating as intended in the design.

- There are some areas where the terminal unit capacities do not meet the peak cooling load. The energy analysis portion of this project will address potential cooling load reduction strategies, aimed at ensuring the design matches the cooling load. These strategies will be documented in the Longer-Term Energy Conservation Measures Memorandum.

SECTION 07530

SINGLE PLY MEMBRANE ROOFING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Contract Conditions, and other Technical Specifications Sections apply to work of this Section insofar as applicable.

1.02 WORK INCLUDED

A. Provide fully adhered elastomeric sheet roofing work as indicated on the Drawings and as specified herein, including, but not limited to the following:

1. Fully adhered membrane.
2. Roof flashings.
3. Roof insulation.
4. Roof expansion joints.
5. Roof walkways.

1.03 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 02070, SELECTIVE DEMOLITION.
2. Section 05310, STEEL DECK.
3. Section 06100, ROUGH CARPENTRY; Wood blocking, cants and nailers.
4. Section 07720, ROOF ACCESSORIES; Roof hatch.
5. Division 15 - MECHANICAL; Roof penetrations and installation of roof-mounted equipment.

1.04 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

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

C 728	Perlite Thermal Insulation Board
D 1622	Apparent Density of Rigid Cellular Plastics
E 96	Water Vapor Transmission of Materials

2. Federal Specifications (Fed. Spec.):

HH-I-529	Insulation Board, Thermal (Mineral Aggregate)
HH-I-1972	Insulation Board, Thermal, Polyurethane and Polyisocyanurate Faced

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide certifications that materials and systems comply with specified requirements.

B. Shop Drawings: Provide large scale shop drawings for installation of all parts of the work. Provide plans, and details of seams, connections and accessory items. Show layouts of tapered insulation and locations of drains. Show interfaces and relationships to work of other trades.

C. Test Reports: Provide certified reports for all specified tests.

1.06 QUALITY ASSURANCE

A. Source: For each material type required for the work of this section, provide primary materials which are the product of one manufacturer. Provide secondary or accessory materials which are acceptable to manufacturers of primary materials.

B. Installer: A firm with a minimum of three years experience in type of work required by this Section and that is acceptable to manufacturers of primary materials.

C. UL Listing: Provide roof system that has been tested and listed by UL as Class A for roof deck, slope and application indicated.

D. Manufacturer's Representative: Make arrangements and pay costs to have manufacturer's authorized representative on roof at beginning of roofing work to advise installer of proper procedures and quality control techniques.

1.07 WARRANTY

A. Furnish manufacturer's warranty stating that manufacturer shall maintain roofing and elastomeric membrane flashings in watertight condition at his own expense for ten years from date of Substantial Completion, provided that Government gives manufacturer written notice of any leak within thirty days from the discovery of such leak. Warranty is solely intended to cover any condition caused by defective materials, installation, or ordinary wear and tear. Warranty shall not cover damage from lightning, full gales, hurricanes, or similar unusual natural occurrences or any condition caused by any deliberate act or by negligence in maintenance.

1.08 PROJECT CONDITIONS

A. Weather: Perform work of this Section only when existing or forecasted weather conditions are within the limits established by manufacturers of the materials and products used.

B. Substrates: Proceed with work only when substrate construction and penetration work is complete.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from weather damage.

B. Sequence deliveries to avoid delays, but minimize on-site storage.

C. Adhesives, cements, mastics and sealers shall be stored between 60°F. and 80°F. should they be exposed to lower temperatures, restore to room temperature for three to five days prior to use. Do not use materials damaged in handling or storage.

D. Store insulation and provide full protection against dampness before laying. Insulation boards shall be dry when applied, and shall be protected from the weather during installation. Any materials damaged by exposure to the elements or other cause shall be rejected and removed promptly from site.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Provide materials and roofing systems from one of the following manufacturers that meet or exceed specified requirements:

a. GenFlex Roofing Systems; GenCorp Polymer Products.
b. HPG Roofing Systems.
c. Sarnafil Inc.

2.02 ROOF SYSTEM

A. Materials and installation shall conform to manufacturer's standard specifications, and work of this Section shall be executed by roofing installer licensed by manufacturer.

B. Provide elastomeric roofing system consisting of adhered single-ply PVC sheet and mechanically-attached insulation over roof deck. Provide system conforming to UL Class A and Factory Mutual Class 1. Roof system shall conform to Factory Mutual Windstorm Resistance Classification 1-120.

2.03 MEMBRANE ROOFING MATERIAL

A. General: Virgin polyvinyl chloride (PVC) with plasticizers and modifiers, formed into uniform flexible sheets, complying ASTM D 4434, Type to suit project.

1. Thickness: 60 mils, nominal.
2. Membrane Reinforcing: Manufacturer's standard glass-fiber or polyester scrim.
3. Exposed Face Color: Grey.

B. Fully Adhered PVC Membrane: Manufacturer's standard installation.

C. Flashing Material: Manufacturer's standard system compatible with single-ply membrane.

D. Slip Sheet at Elastomeric Flashing: Type recommended by membrane manufacturer for protecting membrane from incompatible substrates (elastomeric flashing).

2.04 RIGID ISOCYANURATE INSULATION

A. Isocyanurate Board Insulation: Provide indicated thickness of rigid isocyanurate foam roof insulation consisting of isocyanurate integrally laminated on top and bottom with non-reflective facer. Provide insulation conforming to Fed. Spec. HH-I-1972, and that is acceptable to roofing system manufacturer.

1. Rigid isocyanurate shall have minimum density of 2 lb. cu. ft., minimum compressive strength (ASTM D 1621) of 25 psi, maximum moisture vapor transmission (ASTM E 96) of 2.0 perm, "C" factor of 0.16 (1 in.) or better, and "R" value of 6.67 (1 in.).
2. Insulation shall be approved by Factory Mutual (FM) for Class 1 Insulated Steel Deck Construction and shall be UL listed Class A.
3. Provide tapered boards where indicated for sloping to drain. Fabricate with taper of 1/4 inch per foot, unless otherwise indicated.

B. Anchors for Insulation: Provide mechanical anchors at metal decks and adhered anchors at concrete decks. Provide corrosion-resistant type as recommended by insulation manufacturer for deck type and complying with fire and insurance wind-uplift rating requirements. Provide system tested and approved for FM I-90 wind-uplift rating.

2.05 RECOVERY BOARD

A. Barrier: Type X gypsum wall board, ASTM C 36, 5/8 inch thick.

2.06 VAPOR RETARDER

A. Provide Vaporstop 398, manufactured by Fortifiber Corp., Attlboro, MA 02703, or Architect approved equal.

B. Vapor Retarder Adhesive: Provide Pyro-Kure Roofing Adhesive 402, manufactured by Fortifiber Corp., Attlboro, MA 02703, or Architect approved equal.

2.07 RELATED MATERIALS

A. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, seam caulk, termination reglets, and other accessories recommended by roofing system manufacturer for intended use.

B. Bonding Adhesive: Provide bonding adhesive as recommended by manufacturer. Provide adhesive compatible with all materials and substrates.

C. Splicing Cement: Provide splicing cement and splice cleaners as recommended by membrane manufacturer.

D. Lap Sealant: Provide lap sealant for sealing exposed edge of splices of trowel on gun consistency, and as recommended by membrane manufacturer.

E. Miscellaneous Materials: Provide water cutoff mastic, night sealer, and pourable sealer as recommended by membrane manufacturer.

F. Prefabricated elastomeric accessories (pipe seals, inside and outside corners, etc.) shall be as manufactured and recommended by membrane manufacturer.

G. Nailing Strips and Fasteners: Nailing strips shall be extruded rubber and mechanical fasteners approved by system manufacturer.

H. Insulation Fasteners: System manufacturer's recommended 3 in. diameter metal plate and hammer-driven, non-threaded, black epoxy-coated fastener for metal decks.

I. Roofing Nails: 11 gauge hot-dip galvanized, length to penetrate wood members at least 7/8 in., with 5/8 in. diameter heads, as recommended by membrane manufacturer.

J. Restraining and Termination Bars: Provide system manufacturer's recommended galvanized metal bars in shapes and configurations required to secure insulation at edges and at slope. Provide fasteners as required.

2.08 ROOF WALKWAY

A. Walkway Pads: Slip resistant, chemical resistant, scrim reinforced PVC based pads, approximately 0.15 in. thick. Pads shall be "Hi-Tred" Walkway Pads as manufactured by JPS Elastomerics Coprporation, or approved equal. Pads shall be grey to match roofing. Provide sufficient number of pads to construct a four foot wide path from roof access point to all roof top

equipment.

B. Walkway Pavers: Provide 23-1/2 in. x 23-1/2 in. x 1-13/16 in. standard walkway pavers, minimum 23 lbs. per sq. ft. Provide Hanover Standard Walkway and Ballast Pavers, manufactured by Hanover Architectural Products, Inc., or Architect approved equal. Color shall be natural.

2.09 FLEXIBLE EXPANSION JOINT COVERS

A. Expansion joint cover shall be preformed elastomeric PVC bellows with preformed aluminum flange bonded adhesively and mechanically to each edge of bellows. Sizes, configuration, and location shall be as indicated on Drawings.

B. Provide prefabricated corners, ends, cross-overs, and other appurtenances as required for specific conditions. Do not field fabricate components for which prefabricated components are available.

C. Provide manufacturer's standard grommeted 1-3/4 in. hold-tite nails, adhesives, neoprene flashings, caulking, and other appurtenant materials as recommended by expansion joint manufacturer.

PART 3 EXECUTION

3.01 INSPECTION OF SURFACES TO RECEIVE MEMBRANE ROOFING

A. Carefully check roof deck areas for conditions affecting application and performance. Report defects in writing to Construction Manager. Do not proceed with roofing work until defects have been corrected.

B. Beginning work shall constitute acceptance of its conditions and any defects in roofing work resulting from such accepted surfaces shall be corrected without further expense to the Authority.

3.02 MEMBRANE ROOFING, GENERAL

A. Surfaces to receive roofing materials shall be rigid, tight, clean, dry, smooth, free of scale, dust, oil, or other foreign matter, and also free of frost or the effects of freezing. Thoroughly clean surfaces to remove loose particles immediately before application of subsequent materials. Do not apply roofing materials over wet subsurfaces.

B. Where surface joints at roof and wall substrates exceed 1/4 in. width, fill flush with surface with pourable sealer before proceeding with the installation.

C. Do not leave unfinished roof areas uncovered overnight or during inclement weather.

D. Work shall conform to manufacturer's published specifications, and the published standards of UL. Roof shall be made permanently weatherproof in continuous operation, including connection to flashing and gravel stops.

E. Comply with manufacturer's recommended details and adopt their principles of design. Provide manufacturer's recommended weatherproofing method at projections, connections to sheet metal gravel stops and flashings and at other special conditions.

F. Do not damage or stain surrounding work. Remove stains and repair damage immediately, as work progresses, as part of work of this Section.

G. Proceed with flashing work concurrently with roof installation to prevent water entry at flashing locations.

H. Cutting and Patching: Provide all cutting and patching of roofing work as required to make way for new work.

3.03 ROOF INSULATION

A. Install only as much insulation daily as can be covered with roofing by close of work. Do not expose materials to rain or snow, nor overnight. Replace material that becomes wet.

B. Attach insulation to roof deck with spots of cold adhesive and mechanical fasteners spaced according to Factory Mutual Loss Prevention Data Sheet 1-28 for 1-90 Windstorm Resistance Classification. Cut insulation to fit around roof penetrations and projections. Trim edges of insulation boards so that no edge is left unsupported. Stagger transverse joints in insulation 2 ft. in adjacent rows and butt edges tightly. Joints between boards shall be less than 1/4 in. wide.

C. Feather or taper insulation around drains for smooth transition between roof surface and drain clamp ring.

3.04 MEMBRANE ROOFING INSTALLATION

A. General: Start installation only in presence of manufacturer's technical representative. Cut out and repair membrane defects at the end of each day's work.

B. Fully Adhered Membrane: Adhere membrane to insulation, and plywood where indicated, in conformance with approved submittals, including manufacturer's published instructions and details. Install membrane by unrolling over prepared substrate, lapping adjoining sheets as recommended by manufacturer. Apply adhesive to surfaces to be bonded and roll into place when adhesive has properly cured. Provide heat welded seams. Install mechanical fasteners, flashings and counterflashings, and accessories at locations and as recommended by manufacturer.

C. Elastomeric Flashings Which Are Part of Roofing System: Provide elastomeric sheet flashings at elastomeric sheet roofing work, as indicated.

1. Use longest practical lengths and widths of elastomeric sheet flashing material to eliminate or minimize joints. Complete splices between flashings and main roof sheet before bonding flashings to vertical surfaces. Splices shall be sealed 3 in. beyond fasteners that attach membrane to horizontal nailer in same manner as splices within roofing membrane. Flashings shall be bonded 100% to subsurfaces, except at coves where movement is anticipated, where flexible tube shall be installed.
2. Apply bonding adhesive to flashing and surface to which it is being bonded. When bonding adhesive has dried to the point where it does not string or stick to a dry finger touch, roll flashing into adhesive. Do not bridge flashing at changes of direction.
3. Nail top of flashing 12 in. on center under sheet metal copings, counterflashing, and other sheet metal work.
4. Pipe Flashing: Flash penetrating pipe, conduit, and duct penetrations with prefabricated pipe seals where possible and field-fabricated seals were necessary.
5. Expansion Joints: Treat expansion joints as indicated in expansion joint manufacturer's standard details and published instructions for specific conditions.
6. Unusual Penetrations: Seal clusters of pipes and unusually shaped penetrations with pourable sealer, 2 in. deep in pitch pocket seal, as indicated in manufacturer's standard details and published instructions for specific conditions.
7. Roof drains: Install membrane into drain flange and seal between membrane and drain base with water cut-off mastic, as indicated in manufacturer's standard details and published instructions for specific conditions.

3.05 ROOFTOP WALKWAY

A. Install walkway pads and paver over roof membrane in pattern and layout indicated. Adhere to roof membrane in accordance with roof manufacturer's recommendations. Maintain minimum of 6 in. between panels. Maintain straight joint lines.

3.06 CLEANING

A. Keep surrounding surfaces clean as work progresses.

END OF SECTION

SECTION 07720

ROOF ACCESSORIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Contract Conditions, and other Technical Specifications Sections apply to work of this Section insofar as applicable.

1.02 WORK INCLUDED

A. Provide roof accessories, as indicated on Drawings and as specified herein. Include, but do not limit to:

1. Roof access hatches.

1.03 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 05500, METAL FABRICATIONS.
2. Section 06100, ROUGH CARPENTRY; Treated wood nailers.
3. Section 07530, SINGLE PLY MEMBRANE ROOFING.
4. Section 07900, JOINT SEALERS.
5. Section 09900, PAINTING.

1.04 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.

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

A 525	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
D 2822	Asphalt Roof Cement
E 84	Test Method for Surface Burning Characteristics of Building Materials

2. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):

Manual	Architectural Sheet Metal Manual

3. National Roofing Contractors Association (NRCA):

Manual	Roofing and Waterproofing Manual

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each material used. Provide

certifications that materials and systems comply with specified requirements.

B. Shop Drawings: Provide large scale shop drawings for fabrication, installation and erection of all parts of the work. Provide plans, elevations, and details of anchorage, connections and accessory items. Provide installation templates for work installed by others. Show all interfaces and relationships to work of other trades.

C. Verification Samples: Submit representative samples of each material that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide samples having minimum size of 144 sq. in.

1.06 QUALITY ASSURANCE

A. Source: For each roof accessory type required for the work of this section, provide primary units which are the product of one manufacturer. Provide secondary or accessory materials which are acceptable to the manufacturers of the primary materials.

B. Comply with SMACNA Manual standard details and specifications for fabrication of units, including flanges and cap flashing.

C. Comply with NRCA Manual details for installation of units.

D. Provide roof accessory units designed to withstand 20 psf internal loading and 45 psf external loading.

1.07 PROJECT CONDITIONS

A. Weather: Perform work of this Section only when existing or forecasted weather conditions are within the limits established by manufacturers of the materials and products used.

B. Substrates: Proceed with work only when substrate construction and penetration work is complete. Coordinate installation with roofing and flashing trades.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in unopened, factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Store under cover and protect from weather damage.

B. Sequence deliveries to avoid delays, but minimize on-site storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Roof Access Hatch: Provide roof access hatch products from one of the following manufacturers that meet or exceed the requirements specified:

1. Bilco Co.
2. Babcock-Davis Hatchways, Inc.
3. Dur-red Products.
4. Wasco Products, Inc.

2.02 MATERIALS

A. Zinc-Coated Steel: Provide commercial quality, ASTM A 525, G90 hot-dip galvanized and mill phosphatized.

B. Insulation: Provide manufacturer's standard rigid or semi-rigid glass fiberboards, minimum 1 in. thickness.

C. Wood Nailers: Specified in Section 06100, ROUGH CARPENTRY.

D. Gaskets: Manufacturer's standard neoprene or PVC.

E. Isolation Coating: SSPC Paint-12, solvent type bituminous mastic.

F. Roofing Cement: ASTM D 2822, asphaltic.

G. Sealants: Specified in Section 07900, JOINT SEALERS.

2.03 PRODUCTS

A. Roof Access Hatches: Provide manufacturer's standard galvanized steel single-leaf units of sizes indicated. Provide units with welded or sealed mechanical corners, and as follows:

1. Curb Type: Insulated, double-walled, minimum 8 in. high.
2. Lids: Insulated double-walled, with gaskets.
3. Opening Mechanisms: Spring loaded or counter balanced to reduce opening effort.
4. Operation Device: Inside and outside manual opening device.
5. Locking: Hasp to receive padlock on interior.
6. Counterflashing: Counterflashing coordinated with roofing system.

2.04 FABRICATION

A. Fabricate work to be truly straight, plumb, level and square.

B. Fabricate work to sizes, shapes, and profiles indicated on approved shop drawings.

C. Fabricate work with uniform, tight joints.

2.05 FINISHES

A. Galvanized Repair Paint for Galvanized Steel Members: Provide one of the following:

1. PPG Speedhide Galvanized Steel Paint.
2. ZRC Cold Galvanizing Compound.
3. Rust-Oleum Galvanized Metal Primer.

B. Factory-Applied Primer: Provide minimum 1.0 mil dry film thickness of factory-applied primer, suitable for field-applied finish paint.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine substrates, supports, and conditions detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning of installation shall constitute acceptance of substrates and conditions.

3.02 INSTALLATION

A. General Installation Requirements: Strictly comply with manufacturer's instructions and recommendations, except where more restrictive requirements are specified in this section.

B. Installation: Install units plumb, level, in alignment and plane without warp or rack. Anchor

securely in place.

1. Where slope of roof deck exceeds 1/4 in. per ft., taper units to match slope, to result in level installation of tops.

C. Coordinate roof accessory installation with roof deck and roof system to ensure proper weathertight installations.

D. Isolate dissimilar metals with isolation coating. Make sure that coating is compatible with membrane roofing system.

E. Set roof accessory units with flanges set in a full bed of sealant. Comply with requirements of Section 07900, JOINT SEALERS for materials and installation.

F. Fill voids between ribs in steel deck with mineral roof packing insulation.

G. Provide counterflashing or cap flashing as an integral part of each roof accessory unit. Install to overlap roofing flashing, specified in roofing section.

3.03 ADJUSTING, CLEANING, TOUCH-UP, AND PROTECTION

A. Adjust hardware, operating parts and other similar items to work easily, smoothly, and correctly.

B. Clean exposed surfaces using manufacturer recommended materials and methods. Remove and replace work which cannot be successfully cleaned.

C. Touch-up damaged coatings and finishes. Eliminate all visible evidence of repair.

D. Provide temporary protection at all times during the course of the work, and immediately after completion to ensure the work of this Section is not damaged or deteriorated in any way at time of final acceptance. Remove temporary protections and reclean as necessary immediately prior to final acceptance.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings, Contract Conditions, and other Technical Specifications Sections apply to work of this Section insofar as applicable.

1.02 WORK INCLUDED

A. Caulk and seal joints as indicated on the Drawings and as specified. Include, but do not limit to:

1. Sealing of joints between perimeter of exterior door frames, window frames, metal panels, vents, louvers, and other items occurring in openings in exterior masonry walls, and the surrounding construction, including bed sealing of thresholds.
2. Sealing of interior perimeter joints at door frames, window frames, vents, louvers, and other wall openings.
3. All other interior sealing called for, or reasonably inferred from the Drawings, and as required to provide weathertight conditions in exterior assemblies.

1.03 RELATED WORK

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 07270, FIRESTOPPING; Fire resistive sealants and caulks.
2. Section 08800, GLASS AND GLAZING; Glazing sealants and gaskets.
3. Section 09250, GYPSUM DRYWALL; Concealed acoustical sealants.

1.04 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.

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

C 719	Adhesion and Cohesion of Elastomeric Joint Sealants under Cyclic Movement
C 790	Use of Latex Sealing Compounds
C 834	Latex Sealing Compounds
C 920	Elastomeric Joint Sealants
C 962	Use of Elastomeric Joint Sealants
D 412	Test Methods for Rubber Properties in Tension
D 624	Test Method for Rubber Property - Tear Resistance

2. Federal Specifications (Fed. Spec.):

TT-S-00227	Sealing Compound: Elastomeric Type, Multi-Component (For Calking, Sealing, and Glazing in Buildings and Other Structures)
TT-S-001543A	Sealing Compound: Silicone Rubber Base (For Calking, Sealing, and Glazing in Buildings and Other Structures)

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's printed product data, specifications, standard details, installation instructions, use limitations and recommendations for each sealant material used. Provide certifications that sealant materials comply with specified requirements.

B. Initial Selection Samples: Submit samples manufacturer's color charts showing complete range of colors, textures, and finishes available for each material used.

C. Verification Samples: Submit actual representative samples of each sealant material that is to be exposed in the completed work. Show full color ranges and finish variations expected. Provide sealant samples having minimum size of 4 in. long.

D. Test Reports: Provide certified reports for all specified tests.

1.06 COMPATIBILITY

A. Provide sealant and sealant joint backing materials suitable for the use intended and compatible with the materials with which they will be in contact. Compatibility of sealant and accessories shall be verified by the sealant manufacturer.

1.07 QUALITY ASSURANCE

A. Source: For each sealant material type required for the work of this section, provide primary materials which are the product of one manufacturer. Provide secondary or accessory materials which are acceptable to the manufacturers of the primary materials.

B. Installer: A firm with a minimum of five years experience in type of work required by this Section and which is acceptable to the manufacturers of the primary materials.

C. Mock-Ups: Prior to commencing the primary work of this Section, provide mock-ups at locations acceptable to Architect. Obtain Architect's acceptance of visual qualities. Protect and maintain accepted mock-ups throughout the remainder of the work of this section to serve as criteria for acceptance of the work.

1.08 PROJECT CONDITIONS

A. Weather: Perform work of this Section only when existing or forecasted weather conditions are within the limits established by manufacturers of the materials and products used.

B. Substrates: Proceed with work only when substrate construction and penetration work is complete.

1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Materials under this Section shall be delivered to, and stored at, the job site in unbroken factory sealed containers with labels intact.

1.10 WARRANTY

A. Furnish joint sealant manufacturer's written single-source performance warranty that joint sealant work will be free of defects related to workmanship or material deficiency for five years

from date of Substantial Completion of the Project.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Before installation check each sealant for compatibility with adjacent materials and surfaces and with indicated exposures. Select sealers which are recommended by manufacturer for each application indicated. Where exposed to pedestrian or vehicular traffic, provide sealants which are non-tracking and are strong enough to withstand the traffic without damage.

B. Provide colors as selected by Architect from manufacturer's standard and special (Tremco Fastpak) colors. Where specifically requested, provide custom color matches.

2.02 SELF-LEVELING POLYURETHANE SEALANT

A. Provide two or more part, self-leveling, polyurethane based elastomeric sealant, complying with ASTM C 920, Fed. Spec. TT-S-00227E Type 1 Class A, having Shore A hardness of not less than 30 when tested according to ASTM C 920, cured modulus of elasticity at 100% elongation of not more than 150 psi when tested according to ASTM D 412, and tear resistance of not less than 50 lbs./inch when tested according to ASTM D 624.

B. Where joint surfaces contain bituminous materials, provide modified sealants which are compatible with bituminous materials encountered.

C. Provide one of the following products that meet or exceed specified requirements:

1. Tremco THC 900.
2. Pecora Urexpan NR-200.
3. Mameco Vulkem 245 or 255.
4. Sika 2C, SL.
5. Sonneborn Sonolastic PvJtSt.

D. Extent: Provide self-leveling polyurethane sealant for floor joints not indicated to be sealed with another type of sealant.

2.03 NON-SAG POLYURETHANE SEALANT

A. Provide multi-part, non-sag, polyurethane based elastomeric sealant, complying with ASTM C 920 Type M, Grade NS, Class 25, Fed. Spec. TT-S-00227E Class A, having Shore A hardness of 20 to 30, cured modulus of elasticity at 100% elongation of not more than 75 psi, and tear resistance of not less than 50 lb./in. when tested according to ASTM D 624.

B. Provide one of the following products that meet or exceed specified requirements:

1. Tremco Dymeric.
2. Mameco International Vulkem 227.
3. Harry S. Peterson Co. Iso-Flex 2000.
4. Sika Sikaflex 2c NS.
5. Sonneborn Sonolastic NP 2.

C. Where joint requires 50% movement capabilities, provide Tremco Dymeric Plus, or equal product approved by Architect.

D. Extent: Provide non-sag polyurethane sealant for all masonry to metal panel joints, masonry to masonry joints, masonry to granite joints, and other joints not indicated to be sealed with another type of sealant.

2.04 SILICONE RUBBER SEALANT

A. Provide one part, silicone rubber based elastomeric sealant, complying with ASTM C 920 Type S, Class 25, Grade NS and Fed. Spec. TT-S-001543A Class A.

B. Provide mold and mildew resistant, sanitary interior type sealant.

C. Provide one of the following products that meet or exceed specified requirements:

1. Dow 786.
2. General Electric 1702 Sanitary.
3. Pecora 863.
4. Rhodorsil 6b White.
5. Sonneborn OmniPlus.
6. Tremco Proglaze.

D. Extent: Provide silicone rubber sealant for interior joints around plumbing fixtures and tile to tile joints in ceramic tile work.

2.05 ACRYLIC LATEX SEALANT

A. Provide permanently flexible, latex rubber modified acrylic emulsion sealant, complying with ASTM C 834.

B. Provide one of following products that meet or exceed specified requirements:

1. Pecora AC-20.
2. Tremco Acrylic Latex 834.
3. Sonneborn Sonolac.

C. Extent: Provide acrylic latex sealant for use at mirrors, for exposed acoustical sealant, and for interior joints except where silicone rubber sealant is indicated.

D. At interior joints greater than 1/2 in. in width or subjected to periodic building movement, substitute exterior type sealant specified above.

E. Where surrounding wall surfaces are to be left unpainted, substitute exterior type sealant as specified above.

2.06 PREFORMED JOINT SEALER

A. Preformed Resilient Joint Sealer: Preformed Resilient Joint Sealer for use at building expansion joints in exterior concrete and masonry walls where specifically called for on Drawings shall be preformed, resilient, extruded polychlorophrene elastomeric joint sealer, conforming to ASTM D 2628 and AASHTO M 220 of indicated configuration(s), in continuous lengths, set in manufacturer's recommended primer-lubricating-adhesive consisting of moisture curing polyurethane and aromatic hydrocarbon solvent mixture (73% solid by weight) concrete gray color, equal to one of the following:

1. D.S. Brown Co.
2. Watson Bowman Acme Corp.

2.07 PREFORMED, PRECOMPRESSED, IMPREGNATED FOAM SEALANT

A. Provide manufacturer's standard preformed, precompressed, impregnated open-cell foam sealant manufactured from high-density urethane foam impregnated with a nondrying, water-repellent agent; factory-produced in precompressed sizes in roll or stick form to fit joint widths indicated. Provide foam sealant permanently elastic, mildew-resistant, nonmigratory,

nonstaining, compatible with substrates, and complying with the following requirements:

1. Impregnating Agent: Manufacturer's standard.
2. Density: 8 to 10 lb./cu. ft.
3. Backing: Manufacturer's standard pressure sensitive adhesive, factory applied to one side, with protective wrapping.

B. Provide one of the following products, or Architect approved equal:

1. Emseal Greyflex; Emseal Corp.
2. Will-Seal 150; Wil-Seal Construction Foams Div., Illbruck.
3. York-Seal 100; York Manufacturing, Inc.

2.08 MISCELLANEOUS MATERIALS

A. Primer: Provide primer recommended by sealant manufacturer for surfaces to be adhered to.

B. Bond Breaker Tape: Provide polyethylene or other plastic tape recommended by sealant manufacturer to prevent three-sided adhesion.

C. Backer Rod: Provide compressible rod of durable nonabsorptive material recommended by sealant manufacturer for compatibility with sealant. Provide products of one of the following manufacturers:

1. Backer Rod Manufacturing and Supply Co.
2. Dow Chemical Co.
3. Williams Products, Inc.
4. Woodmont Products, Inc.

D. Joint backing for general use at joints in horizontal surfaces shall consist of two rows of butyl rubber or neoprene foam rod in contact with one another, and each compressed to approximately 2/3 original width when in place.

E. Provide miscellaneous materials of type that will not bleed through sealant, discolor surface, or produce other deleterious effects. Select size to provide compression to approximately 2/3 original width when in place. Provide backing material profile concave to the rear of the sealant, and equipped with a bond-breaking film.

PART 3 EXECUTION

3.01 INSPECTION

A. The Installer shall examine substrates and conditions under which this work is to be performed and notify Contractor, in writing, of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning of sealant work means Installer's acceptance of joint surfaces and conditions.

3.02 PREPARATION

A. Strictly comply with manufacturers' instructions and recommendations, except where more restrictive requirements are specified in this Section.

B. Clean joint surfaces immediately before installation of sealants, primers, tapes and fillers. Remove substances which could interfere with bond. Etch or roughen joint surfaces to improve bond. Surfaces which have been given protective coatings and those that contain oil or grease shall be thoroughly cleaned with xylol or MEK solvent, with due precautions taken to minimize hazards.

C. Unless otherwise indicated, use of sealants shall conform to the following: ASTM C 790 for latex sealants and ASTM C 962 for other sealants.

D. Tape or mask adjoining surfaces to prevent spillage and migration problems.

E. Prime surfaces as recommended by sealant manufacturer.

3.03 INSTALLATION

A. Schedule work as long as possible after completion of concrete work and finished brick masonry and granite work.

B. Provide backer rods for sealants except where specifically recommended against by sealant manufacturers.

C. Prevent three sided adhesion by use of bond breaker tapes or backer rods.

D. Force sealant into joints to provide uniform, dense, continuous ribbons free from gaps and air pockets. Completely wet both joint surfaces equally on opposite sides.

E. Except in hot weather, make sealant surface slightly concave. Install sealants so that compressed sealants do not protrude from joints. Dry tool sealants to form a smooth dense surface. At horizontal joints form a slight cove to prevent trapping water.

F. Provide sealants to depths indicated, or if not indicated, follow manufacturer's recommendations. For joints up to 3/8 in. width, depth of joint shall not exceed 1/2 in.; for joints larger than 1/2 in. width, depth of joint shall not exceed 5/8 in.

3.04 EXTENT OF SEALANT WORK

A. General Extent: Seal joints indicated, and all interior and exterior joints, seams, and intersections between dissimilar materials. Provide elastomeric sealant installation with backer rod in all interior and exterior control joints.

B. Exterior Sealing: Without limitation, the work of this Section includes sealing the following:

1. Masonry to masonry joints.
2. Masonry to other exterior wall materials, including concrete, metal, and wood.
3. Joints and cracks in paving and walks.
4. Joint fillers for all joints.

C. Interior Sealing: Without limitation, the work of this Section includes sealing the following:

1. Perimeters of door frames, window frames, and metal and wood frames.
2. Metal to gypsum drywall joints.
3. Top of wall base along irregular walls.
4. Between acoustical ceiling edge angle and irregular walls.
5. Tile to tile joints inside corners, tile to metal joints, and tile to gypsum drywall joints.
6. Splash to counter joints and splash to wall joints at countertops.
7. Completely around plumbing fixtures, fittings, and trim to countertops, walls and floors.
8. Exposed acoustical sealants, at tops and bottoms of stud partition walls around mechanical rooms, toilet rooms, and at other acoustic partitions as indicated.

D. Thresholds of exterior doors shall be set in full beds of exterior sealant, not less than 3/8 in. thick. At Contractor's option, a polybutene or polyisobutylene sealant by same manufacturer may be used at thresholds.

3.05 CURING

A. Cure sealants in strict compliance with manufacturers' instructions and recommendations to obtain highest quality surface and maximum adhesion. Make every effort to minimize accelerated aging effects and increase in modulus of elasticity.

3.06 CLEANING AND PROTECTION

A. Remove smears from adjacent surfaces immediately, as the work progresses. Exercise particular care to prevent smearing or staining of surrounding surfaces which will be exposed in the finished work, and repair any damage done to same as result of this work without additional cost to Owner.

B. Remove and replace work that is damaged or deteriorated.

C. Clean adjacent surfaces using materials and methods recommended by sealant manufacturer. Remove and replace work that cannot be successfully cleaned.

D. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protection immediately before final acceptance.

END OF SECTION

SECTION 07531 - EPDM SINGLE-PLY MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Mechanically fastened sheet roofing.
2. Vapor retarder.
3. Roof insulation.
4. Walkway pads.

B. Related Sections include the following:

1. Division 6 Section "Miscellaneous Carpentry" for wood nailers, curbs, and blocking.
2. Division 7 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
3. Division 7 Section "Joint Sealants."
4. Division 15 Section "Plumbing Specialties" for roof drains.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 for definition of terms related to roofing work not otherwise defined in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General: Install sheet membrane roofing and base flashing that are watertight; will not permit the passage of liquid water; and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. FM Listing: Provide sheet membrane, base flashings, and component materials that meet requirements of FM 4450 and FM 4470 as part of a roofing system and that are listed in FM's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM markings.

1.5 SUBMITTALS

A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Include plans, sections, and details of the following:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.

C. Samples for Verification: Of the following products:

1. 12-by-12-inch (300-by-300-mm) square of sheet roofing, of color specified, including T-shaped side and end lap seam.

2. 12-by-12-inch (300-by-300-mm) square of roof insulation.

3. 12-by-12-inch (300-by-300-mm) square of walkway pads or rolls.

4. 12-inch (300-mm) length of metal termination bars.

5. 2 insulation fasteners of each type, length, and finish.

6. 2 roof cover fasteners of each type, length, and finish.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. Upon request, submit evidence of meeting requirements.

F. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

G. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of components of roofing system with requirements based on comprehensive testing of current product compositions.

H. Research/Evaluation Reports: Evidence of roofing system's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

I. Maintenance Data: For roofing system to include in the maintenance manuals specified in Division 1.

J. Warranty: Sample copy of standard roofing system manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.

K. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing roofing similar to that required for this Project and who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product.

B. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and slopes indicated.

C. Preinstallation Conference: Before installing roofing system, conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." Notify participants at least 5 working days before conference.

1. Meet with Owner; Architect; Owner's insurer, if applicable; testing and inspecting agency representative; roofing Installer; roofing system manufacturer's

representative; deck Installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.

4. Review loading limitations of deck during and after roofing.

5. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing.

6. Review governing regulations and requirements for insurance, certificates, and inspection and testing, if applicable.

7. Review temporary protection requirements for roofing system during and after installation.

8. Review roof observation and repair procedures after roofing installation.

9. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.

1.9 WARRANTY

A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Standard Roofing Manufacturer's Warranty: Submit a written warranty, without monetary limitation, signed by roofing system manufacturer agreeing to promptly repair leaks resulting from defects in materials or workmanship for the following warranty period:

1. Warranty Period: 10 years.

C. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including membrane roofing, sheet flashing, roof insulation, fasteners, and vapor retarders, if any, for the following warranty period:

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. EPDM Sheet:

a. Carlisle Syntec Systems; Carlisle Corp.

b. Celotex Corp. (The).

c. Firestone Building Products Co.

d. HPG Roofing Systems.

e. International Diamond Systems.

f. Roofing Products International, Inc.

g. Schuller Roofing Systems.

h. Stafast Roofing Products.

2. Polyisocyanurate Board Insulation:

a. Apache Products Co.

b. Atlas Roofing Corporation.

c. Celotex Corp. (The).

d. GAF Materials Corp.

e. NRG Barriers, Inc.

2.2 EPDM SHEET

A. EPDM Sheet: Uniform, flexible sheet formed from a terpolymer of ethylene-propylene-diene, complying with ASTM D 4637, Type 1, of the following grade, class, thickness, backing, and exposed face color:

1. Grade and Class: Grade 1 and Class U, unreinforced.

2. Thickness: 45 mils (1.1 mm), nominal.

3. Backing: Unbacked.

4. Exposed Face Color: Black.

2.3 AUXILIARY MATERIALS

A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with EPDM membrane roofing.

1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, uncured or cured, according to application.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive.

D. Splice Primer and Tape: Manufacturer's standard synthetic rubber polymer primer and 3-inch- (75-mm-) wide minimum, butyl splice tape with release film.

E. Lap Sealant: Manufacturer's standard single-component sealant.

F. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

G. Metal Termination Bars: Manufacturer's standard aluminum bars, approximately 1 inch (25 mm) wide, roll formed and prepunched.

H. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch (25 mm) wide by 0.05 inch (1.3 mm) thick, prepunched.

I. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions of FM 4470, designed for fastening sheet to substrate, and acceptable to roofing system manufacturer.

J. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, and other accessories recommended by roofing system manufacturer for intended use.

2.4 VAPOR RETARDER

A. Laminated-Sheet Vapor Retarder: Kraft paper, 2 layers, laminated with asphalt and edge reinforced with woven fiberglass yarn with maximum permeance rating of 0.50 perm (29 ng/Pa x s x sq. m) and manufacturer's standard roofing adhesive.

2.5 INSULATION MATERIALS

A. General: Provide preformed roof insulation boards that comply with requirements, selected from manufacturer's standard sizes and of thicknesses indicated.

1. Provide preformed, tapered insulation boards where indicated for sloping to drain. Fabricate with the following taper:

   a. 1/4 inch per 12 inches (1:48), unless otherwise indicated.

2. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

B. Polyisocyanurate Board Insulation: Rigid, cellular polyisocyanurate thermal insulation with core formed by using HCFCs as blowing agents to comply with ASTM C 1289, classified by facer type as follows:

1. Facer Type: Type II, felt or glass-fiber mat on both major surfaces.

2.6 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions of FM 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.

C. Cover Board: Cellulosic-fiber insulating board, ASTM C 208, Type II, Grade 2, 1/2 inch (12.7 mm) thick.

2.7 WALKWAYS

A. Walkway Pads: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick, and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.

B. Verify that roof openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.

C. Verify that wood nailers are in place and secured and match thicknesses of insulation required.

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

3.2 PREPARATION

A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 THERMAL BARRIER

A. Install thermal barrier with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt thermal-barrier boards together.

1. Secure thermal barrier to top flanges of steel deck according to recommendations of FM's "Approval Guide" for specified Windstorm Resistance Classification.

2. Secure thermal barrier to top flanges of steel deck using at least 1 fastener for each 4 sq. ft. (0.38 sq. m) and at least 2 fasteners per board.

3.4 VAPOR-RETARDER INSTALLATION

A. Install laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Bond vapor retarder to deck as follows:

1. Apply adhesive at rate recommended by vapor retarder manufacturer. Seal laps with adhesive.

B. Completely seal vapor retarder at terminations, obstructions, and penetrations.

3.5 INSULATION INSTALLATION

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated and to Shop Drawings.

D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches (50 mm) or greater, install required thickness in 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Attached Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type indicated.

1. Fasten insulation according to requirements of FM's "Approval Guide" for specified Windstorm Resistance Classification and the insulation and roofing system manufacturers' written instructions.

3.6 MECHANICALLY FASTENED SHEET INSTALLATION

A. Install EPDM sheet over area to receive roofing according to roofing system manufacturer's written instructions. Unroll sheet and allow to relax for a minimum of 30 minutes.

B. Start installation of sheet in presence of roofing system manufacturer's technical personnel.

C. Accurately align sheets and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Mechanically or adhesively fasten sheet securely at terminations and perimeter of roofing.

E. Apply roofing sheet with side laps shingled with slope of roof deck where possible.

F. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing sheet in place with clamping ring.

G. In-Splice Attachment: Secure one edge of the sheet using fastening plates or battens centered within the membrane splice and mechanically fasten sheet to roof deck. Field-splice seam according to "Seam Installation" Article.

3.7 SEAM INSTALLATION

A. Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.

B. Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet terminations.

C. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

3.8 FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of flashing sheet at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing as recommended by manufacturer.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 WALKWAY INSTALLATION

A. Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL

A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

1. Notify Architect or Owner 48 hours in advance of the date and time of inspection.

3.11 PROTECTING AND CLEANING

A. Protect sheet membrane roofing from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing that does not comply with requirements, repair substrates, reinstall roofing, and repair sheet flashings to a condition free of damage and deterioration at the time of Substantial Completion and according to warranty requirements.

3.12 ROOFING INSTALLER'S WARRANTY

A. WHEREAS <NAME> of <ADDRESS>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner:
2. Address:
3. Building Name/Type:
4. Address:
5. Area of Work:
6. Acceptance Date:
7. Warranty Period:
8. Expiration Date:

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

   a. lightning;

   b. peak gust wind speed exceeding 90 mph;

   c. fire;

   d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;

   e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;

   f. vapor condensation on bottom of roofing; and

   g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof has been paid by Owner or by another responsible party so designated.

3. The Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents, resulting from leaks or faults or defects of work.

4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the

extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void, unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. The Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <DAY> day of <MONTH>, 19<YEAR>.

1. Authorized Signature:

2. Name:

3. Title:

END OF SECTION 07531

SECTION 07620 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes sheet metal flashing and trim in the following categories:

1. Exposed trim, gravel stops, and fasciae, edge of flashing.
2. Copings.
3. Reglets.
4. Roof expansion-joint covers.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 4 Sections for through-wall flashing and other integral masonry flashings specified as part of masonry work.
2. Division 7 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
3. Division 7 Section "Joint Sealants" for elastomeric sealants.
4. Division 7 Roofing Sections for flashing and roofing accessories installed integral with roofing membrane as part of roofing-system work.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

B. Fabricate and install flashings at roof edges to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the following wind zone:

1. Wind Zone 3: Wind pressures of 46 to 104 psf (2.20 to 4.98 kPa).

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

C. Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.

D. Samples of sheet metal flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.

1. 8-inch- (200-mm-) square Samples of specified sheet materials to be exposed as finished surfaces.

2. 12-inch- (300-mm-) long Samples of factory-fabricated products exposed as finished Work. Provide complete with specified factory finish.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experience Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1. Exposed trim, gravel stops, and fasciae.

2. Copings.

3. Obtain Architect's approval of mockups before start of final unit of Work.

4. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

a. When directed, demolish and remove mockups from Project site.

b. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed Work.

1.6 PROJECT CONDITIONS

A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

PART 2 - PRODUCTS

2.1 METALS

A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:

1. Anodized Aluminum Sheet: ASTM B 209 (ASTM B 209M), 5005-H14, with a minimum thickness of 0.050 inch (1.2 mm).

2. Extruded Aluminum: ASTM B 221 (ASTM B 221M), alloy 6063-T52, with a minimum thickness of 0.080 inch (2.0 mm) for primary legs of extrusions that are anodized, unless otherwise indicated.

B. Stainless-Steel Sheet: ASTM A 167, Type 304, soft annealed, with No. 2D finish, except where harder temper is required for forming or performance; minimum 0.0187 inch (0.5 mm) thick, unless otherwise indicated.

2.2 REGLETS

A. General: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces and compatible with flashing indicated.

B. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fry Reglet Corporation.

2. Hickman: W.P. Hickman Co.

3. Keystone Flashing Company.

2.3 MISCELLANEOUS MATERIALS AND ACCESSORIES

A. Solder for Stainless Steel: ASTM B 32, Grade Sn60, used with an acid flux of type recommended by stainless-steel sheet manufacturer; use a noncorrosive rosin flux over tinned surfaces.

B. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.

C. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coat.

D. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

E. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in Division 7 Section "Joint Sealants."

F. Epoxy Seam Sealer: 2-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior and interior nonmoving joints, including riveted joints.

G. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.

H. Paper Slip Sheet: 5-lb/square red rosin, sized building paper conforming to FS UU-B-790, Type I, Style 1b.

I. Polyethylene Underlayment: ASTM D 4397, minimum 6-mil- thick black polyethylene film, resistant to decay when tested according to ASTM E 154.

J. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.

2.4 FABRICATION, GENERAL

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

D. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

E. Expansion Provisions: Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

F. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

G. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.

H. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

I. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.

1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.5 SHEET METAL FABRICATIONS

A. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.

B. Exposed Trim, Gravel Stops, and Fasciae: Fabricate from the following material:

1. Aluminum: 0.050 inch (1.2 mm) thick.

C. Copings: Fabricate from the following material:

1. Aluminum: 0.050 inch (1.2 mm) thick.

D. Reglets, Flashing Receivers: Fabricate from the following material:

1. Stainless Steel: 0.0156 inch (0.4 mm) thick.

2.6 ALUMINUM FINISHES

A. General: Comply with Aluminum Association's (AA) "Designation System for Aluminum Finishes" for finish designations and application recommendations.

B. Class I, Color Anodic Finish: AA-C22A42/A44 (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 606.1 or AAMA 608.1.

1. Color: As selected by Architect from the full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible, and set units true to line and level as indicated. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.

B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Roof-Edge Flashings: Secure metal flashings at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

D. Expansion Provisions: Provide for thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

E. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except where pretinned surface would show in finished Work.

1. Do not solder the following metals:

a. Aluminum.

F. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant.

1. Use joint adhesive for nonmoving joints specified not to be soldered.

G. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.

1. Underlayment: Where installing stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.

2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.

I. Install reglets to receive counterflashing according to the following requirements:

1. Where reglets are shown in concrete, furnish reglets for installation under Division 3 Section "Cast-in-Place Concrete."

3.3 CLEANING AND PROTECTION

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION 07620

SECTION 07500
ROOFING AND FLASHING

PART 1 – GENERAL

1.01 DESCRIPTION

A. Work Included in This Section:

1. **Provide all labor, materials, equipment, and services, etc., required to furnish and install all membrane roofing, flashing and related work as indicated on the Drawings, Specified herein, or otherwise required for a complete and proper job.**

2. **The Work shall include, but shall not necessarily be limited to:**

   a. **Membrane roofing, flashings, terminations, protective overlayments and walkway pads.**

   b. **Metal flashing, including step, base, cap counter flashing, and terminations.**

   c. **Metal gravel stops, fascias, copings, drip edges, cleats, reglets, gutters, scuppers, pipe covers, and related accessories.**

   d. **Flashing of roof drains, roof fans, Mechanical Equipment, skylights, and any other items that penetrate the roof.**

   e. **Waterstop membrane at eaves, valleys, ridges, and as otherwise indicated on the Drawings.**

   f. **Sealant as required for the installation of roofing and flashing.**

   g. **Preservative treated wood blocking and nailers as detailed or required. (See SECTION 06100: ROUGH CARPENTRY.)**

   h. **Installation of roof drains. (Drains shall be furnished by Mechanical Subcontractor. See DIVISION 15.)**

   i. **Insulation boards related to roofing. (See SECTION 07200: INSULATION.)**

   j. **Roof expansion joints.**

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B. Related Work Specified Elsewhere:

1. SECTION 01000: GENERAL REQUIREMENTS
2. SECTION 04200: UNIT MASONRY AND MORTAR
3. SECTION 05300: STEEL DECKING
4. SECTION 06100: ROUGH CARPENTRY
5. SECTION 07101: SEALING AND FIRESTOPPING
6. SECTION 07200: INSULATION
7. SECTION 07415: PREFINISHED ALUMINUM COMPOSITE PANELS
8. SECTION 08500: ALUMINUM WINDOWS AND ENTRANCES
9. SECTION 08600: INSULATED SKYLIGHTS
10. SECTION 09250: GYPSUM BOARD AND METAL STUDS
11. SECTION 09900: PAINTING AND WALLCOVERING
12. DIVISION 15: MECHANICAL (Roof equipment, roof drains, vent pipes)
13. DIVISION 16: ELECTRICAL (Lightning Protection system)

1.02 SPECIAL INSTRUCTIONS

A. After the Contract has been awarded and after the submission and review of roofing and flashing shop drawings, samples and printed data, a conference shall be held to review the proposed materials, installation procedures, job schedules, appropriate trade sequencing to minimize damage to roofing, determine access, staging and storage areas, establish working weather conditions, establish roofing protection provisions, review considerations for safety of building occupants, and other relevant issues. The following personnel shall be present at the meeting:

Contractor (Project Manager, Superintendent)
Roofing Sub-Contractor (Project Manager, Foreman)
Roofing and Flashing Materials Manufacturers
Roof Accessories Manufacturers
Mechanical Sub-Contractor (project Manager, Foremen)
Architect
Owner's Representative

B. Verify compatibility of all materials to come in contact with roofing, including but not limited to:

1. Treated lumber.
2. Sealants and adhesives.
3. Waterstop membrane.
4. Thru wall flashing. (See SECTION 04200: UNIT MASONRY AND MORTAR.)
5. Insulations and roofing boards.
6. Sheathing.
7. Walkway pads.
8. Existing roofing.
9. All other roofing materials.

C. The Contractor shall assume total responsibility for thoroughly investigating all Architectural, Structural, Mechanical, Electrical, as well as all other Drawings and Specifications and making proper accommodations for all roof penetrations and appurtenances. When provided, the Roof Plan is intended to represent the general configuration of the roof. It does not necessarily indicate all penetrations, accessories, equipment, etc. to be required. The Contractor shall provide all curbs, cants, crickets, flashings, pitchpockets, etc. required for a complete and proper job.

D. Unless specifically noted otherwise, the roofing manufacturer's standard installation details shall apply and shall be considered to be a part of these Contract Documents.

E. Splices into existing roofing to remain shall be made in strict accordance with the roofing manufacturer's instructions. Verify the compatibility of all materials.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, installation instructions and data substantiating that materials comply with specified requirements.

B. Shop Drawings:

1. Submit a roof layout plan. Among other required information the plan shall identify areas and thicknesses of tapered insulation.

2. Submit shop drawings indicating thickness and dimensions of all parts, fastening and anchoring methods, details and locations of all typical shingle laps, seams, joints, and other provisions necessary for thermal expansion and contraction. Key in details on roof layout plan.

3. Submit shop drawings of complete roof flashing including jointing, expansion joint flashing, intersections, intersections with walls, transitions from cants to walls, transitions from curbs to gravel stops, and any other details required for a complete watertight installation. Key in details on roof layout plan.

4. Submit manufacturer's technical data and installation specifications.

5. Submit written certification by the roofing manufacturer that all insulation, underlayment, and related fasteners to be used are satisfactory for their intended applications.

6. Submit final shop drawings to the roofing manufacturer for review as required by warranty requirements.

C. Samples:

1. Metal flashing samples bent to shape approximately 6″ x 12″ of each finish and on each kind of sheet metal specified. (Including vent stack flashing.)

2. Fasteners, each type.

3. Roofing membrane, all types.

4. Roof insulation. See SECTION 07200: INSULATION.

5. Walkway pads.

1.04 QUALITY ASSURANCE

A. Thermoplastic Polyolefin (TPO) membrane roofing and flashing materials shall be the products of the Sure-Seal Universal Roofing Systems as manufactured by Carlisle SynTec Incorporated, or approved equal.

B. The installations shall be executed by a roofing contractor acceptable to or licensed by the manufacturer, where applicable, in order to obtain applicable guarantees.

C. Provide roofing materials with fire-test-response characteristics as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and slopes indicated.

2. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing materials are a part.

1.05 GUARANTEE AND WARRANTEE

A. Applicator/Contractor Warranty: The roofing and flashing subcontractor hereby guarantees that roofing, roof insulation, roof accessories and flashing will be free from defective materials and workmanship for a period of three (3) years) from the date of Substantial Completion. Upon notification of any such defects within said guarantee period the roofing and flashing subcontractor shall promptly make all necessary repairs and replacements at no cost or expense to the Owner. This warranty shall be signed and countersigned by the installer (Roofer) and the Contractor.

B. Manufacturer's System and Membrane Warranties: Upon completion of the membrane roofing system work, the roofing materials manufacturer shall furnish the Owner a "Total System" warranty insuring a watertight roof for a period of ten (10) years. The warranty shall cover all repairs

necessary over the ten (10) year period up to the original cost of the original roofing contract. The membrane shall also be warranted not to prematurely deteriorate to the point of failure because of weathering for a period of twenty (20) years. Warranty shall include maximum peak gust wind speed coverage of up to 55 mph.

1.06 TESTING AND INSPECTION:

A. System Manufacturer's Inspection: Upon completion of the installation, an inspection shall be made by a technical representative of the system manufacturer ascertain that the roofing system has been installed in accordance with the system manufacturer's published specifications and details.

1. The purpose of this inspection is to determine whether a system warranty will be issued by the system manufacturer. Should the technical representative find that the roofing system has not been installed in a manner that qualifies for issuance of the specified system warranty, the system shall not be acceptable to the Owner until the installer has made corrections or repairs, the system has been re-inspected by the system manufacturer's technical representative and the specified roofing system warranty has been issued.

2. Submit a copy of all inspection reports and follow-up reports to the Architect.

B. Independent Roofing Inspection: During the course of the roofing installation, inspections shall be conducted by an independent roofing inspector engaged by the Owner. The cost of independent roofing inspection shall be paid for by the Owner through an Allowance.

1.07 PERFORMANCE REQUIREMENTS

A. General: Install sheet membrane roofing and flashings that are watertight; will not permit the passage of liquid water; and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. FM Listing: Provide sheet membrane, base flashings, and component materials that meet requirements of Factory Mutual as part of a roofing system that are listed in FM's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM markings.

1. Roofing system shall comply with the following:

   a. Fire/Windstorm Classification: Class I-90

D. Roofing System Design: Provide a single-ply roofing system that complies with roofing system manufacturer's written design instructions and with the Single Ply Roofing Institute's "Wind Design Guide for Mechanical Attached Roofing Systems."

1.08 PRODUCT HANDLING

A. All roof system materials that are susceptible to retaining moisture or that may be damaged by moisture shall be stored in a dry location or if stored outside shall be raised off the ground or roof deck and covered with a water-resistant covering that has been properly secured.

B. Materials being stored on a roof surface shall not overload the deck or structural assembly.

C. Lids shall be secured on cans of stored materials and all emulsions, coatings, adhesives, solvents, sealants, foams, etc. shall be stored at temperatures as recommended by the manufacturers.

PART 2 - PRODUCTS

2.01 MEMBRANE ROOFING - GENERAL

A. All components of the specified roofing system shall be products of Carlisle SynTec Incorporated or accepted by Carlisle as compatible or approved equal.

B. All products (including insulation, fasteners, fastening plates and edgings) must be manufactured and supplied by the roofing system manufacturer and covered by the warranty.

2.02 MEMBRANE

A. Furnish Sure-Weld .060" thick gray reinforced TPO (Thermoplastic Polyolefin) membrane as needed to complete the roofing system. Membrane thickness over the reinforcing scrim (top-ply thickness) shall be nominal .015" thick (15 mil).

2.03 INSULATION/UNDERLAYMENT

A. When applicable, insulation shall be installed in multiple layers. The first and second layer of insulation shall be mechanically fastened to the substrate in accordance with the manufacturer's published specifications.

B. Insulation shall be as supplied by Carlisle. Refer to SECTION 07200: INSULATION.

2.04 ADHESIVES AND CLEANERS

A. All products shall be furnished by Carlisle and specifically formulated for the intended purpose.

1. Bonding Adhesive: Sure-Weld

2. Edge Sealant: Cut Edge Sealant

3. Sealer: Water Cut-Off Mastic and CCW-102C Sealant

4. Cleaner: Sure-Seal Weathered Membrane Cleaner

5. Splicing Cement: Sure-Seal EP-95 Splicing Cement

2.05 FASTENERS AND PLATES

A. To be used for mechanical attachment of insulation and to provide additional membrane securement:

1. HP-X Fasteners: A heavy duty #15 threaded fastener with a phillips head used for membrane securement into steel, wood plank or minimum 15/32 inch thick plywood.

2. HP Fasteners: A threaded, black epoxy electro-deposition coated fastener used with steel and wood roof decks for insulation attachment.

3. Concrete Spikes: A non-threaded, black epoxy electro-deposition coated fastener used with structural concrete roof decks rated 3,000 psi or greater.

4. HP-14-10 Fasteners: A #14 threaded fastener used for minimum 3,000 psi concrete decks.

5. Piranha Plates: A 2-3/8 inch diameter metal barbed fastening plate used with Carlisle HP-X or HP-14-10 Fasteners for membrane securement. This plate can be used for insulation securement.

6. Insulation Fastening Plates: A nominal 3 inch diameter metal plate used for insulation attachment with the appropriate Carlisle Fastener.

2.06 METAL EDGING AND MEMBRANE TERMINATIONS

A. Sure-Seal SecurEdge Coping: Incorporates a 20 gauge anchor cleat with 4 pre-slotted holes, a concealed joint cover and 10 foot continuous sections of coping cap; width as required for project details. Metal

coping cap color shall be custom color to match prefinished aluminum composite panel.

B. Roof Insulation: See SECTION 07200: INSULATION. Provide tapered boards where indicated for sloping to drain. Fabricate with taper of 1/4" per foot. All roof drains shall be sumped in a 4' x 4' area.

2.07 METAL WORK MATERIALS - ALUMINUM

A. Prefinished Aluminum: (All exposed roofing metal work except flashing built into masonry.) Shall be prefinished, architectural alloy 6063-TS aluminum, smooth face, unless otherwise indicated. Material shall be of gauge hereinafter specified for specific locations:

1.	Drip Edges:	.040
2.	Coping:	.100
3.	Base Flashing:	.040
4.	Gravel Stops and Fascias:	.050
5.	Cleats:	.060
6.	Scuppers and Gutters:	.060
7.	Diverters:	.060
8.	Miscellaneous:	.040 (Unless otherwise noted on the Drawings.)

Finish shall be a high performance coating, AA-C12C42R1x, cleaned with inhibitve chemicals and conversion coated with an inhibitive thermo-cured primer, 0.2 dry mil minimum thickness, and fluorocarbon coating "Kynar 500", 1.0 dry mil thickness. Color shall be as selected by the Architect from the manufacturer's full range of custom colors. Coating shall be guaranteed against premature failure for 20 years. Finish shall withstand brakeforming without visible signs of damage.

2.08 MISCELLANEOUS MATERIALS

A. Roof Insulation: Shall be as specified in SECTION 07200: INSULATION.

B. Mineral Board: Shall be as specified in SECTION 07200: INSULATION.

C. Preservative Treated Wood Blocking: Shall be as specified in SECTION 06100: ROUGH CARPENTRY.

D. Cants: Shall be as recommended by the roofing manufacturer.

E. Sponge Tubing: Shall be "Ethafoam" as manufactured by Dow Chemical Co., or approved equal. Tubing shall be sized to suit job conditions.

F. Fasteners:

1. Nails for metal flashing shall be hot dipped galvanized steel, large flathead (3/8" head minimum), barbed, wire slating nails, not less

than No. 12-gauge, 1" long minimum, additional length as required to suit job conditions.

G. Waterstop Membrane: Shall be 40 mil thick, 36" wide roll, rubberized asphalt and polyethylene. Waterstop shall be "Vicor Ice and Watershield Membrane" as manufactured by W.R. Grace and Company, or approved equal. Provide primer as recommended by the manufacturer.

H. Roofing Cement: Shall be as recommended by the materials manufacturer and shall be compatible with all adjacent materials.

I. Roof Expansion Joints: Shall be by membrane roof system manufacturer to accommodate joint width.

PART 3 – EXECUTION

3.01 GENERAL

A. Comply with the manufacturer's published instructions for the installation of the membrane roofing system including proper substrate preparation, jobsite considerations and weather restrictions.

B. Position sheets to accommodate contours of the roof deck and shingle splices to avoid bucking water.

3.02 INSULATION PLACEMENT AND ATTACHMENT

A. Install insulation or membrane underlayment over the substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch. Stagger joints both horizontally and vertically if multiple layers are provided.

B. Secure insulation to the substrate with the required Carlisle fasteners and plates in accordance with manufacturers specifications.

3.03 MEMBRANE PLACEMENT AND ATTACHMENT

A. Unroll and position membrane without stretching. Provide and secure both perimeter and field membrane sheets in accordance with the manufacturer's most current specifications and details.

B. Secure the membrane with the required Carlisle Fasteners and Plates spaced a maximum of 12 inches on center depending or project conditions (centered over the pre-printed marks approximately 1-1/2 inches from the edge of the membrane sheet).

C. Install adjoining membrane sheets in the same manner in accordance with the manufacturer's specifications.

3.04 MEMBRANE SPLICING/HOT AIR WELDING PROCEDURES

A. Hot air weld the Sure-Weld membrane using an Automatic Hot Air Welding Machine or Hot Air Hand Welder in accordance with the manufacturer's specifications. At all splice intersections, roll the seam with a silicone roller prior to membrane seam cooling. Note: When using .060" thick membrane, all splice intersections shall be overlaid with Sure-Weld non-reinforced flashing.

B. Probe all seams once the hot air welds have thoroughly cooled (approximately 30 minutes).

C. Repair all seam deficiencies the same day they are discovered.

D. Apply Cut Edge Sealant on all cut edges of reinforced membrane (where the scrim reinforcement is exposed) after seam probing is complete.

3.05 FLASHING

A. Flashing of parapets, curbs, expansion joints and other parts of the roof must be performed using Sure-Weld reinforced membrane. Sure-Weld non-reinforced membrane can be used for flashing pipe penetrations, Sealant Pockets, scuppers, as well as inside and outside corners when the use of pre-fabricated accessories is not feasible.

B. Follow manufacturer's typical flashing procedures for all wall, curb, and penetration flashing including metal edging/coping and roof drain applications.

3.06 WALKWAYS

A. Install walkways at all traffic concentration points (such as roof hatches, access doors, rooftop ladders, etc.) and all locations as identified on the specifier's drawing.

B. Hot air weld walkway pads to the membrane in accordance with the manufacturer's specifications.

3.07 DAILY SEAL

A. On phased roofing, when the completion of flashings and terminations is not achieved by the end of the work day, a daily seal must be performed to temporarily close the membrane to prevent water infiltration.

B. Complete an acceptable membrane seal in accordance with the manufacturer's requirements.

3.08 CLEAN UP

A. Perform daily clean-up to collect all wrappings, empty containers, paper, and other debris from the project site. Upon completion, all debris must be disposed of in a legally acceptable manner.

B. Prior to the manufacturer's inspection for warranty, the applicator must perform a pre-inspection to review all work and to verify all flashing has been completed as well as the application of all caulking.

3.09 GENERAL REQUIREMENTS FOR METAL FLASHING

A. Metal flashing installed in conjunction with membrane roof shall meet the requirements of the membrane roof manufacturer. Confirm that all materials and details will not in any way void the roof membrane system warrantee.

B. Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather, without failing. Fabricate and install flashings and roof edges to fully comply with the recommendations of Factory Mutual (FM) Loss Prevention Data Sheet 1-49 for the applicable wind zone.

C. Schedule and coordinate sheet metal installations with the work of other trades where it is integral or continuous therewith. Materials furnished under this Section that are to be built-in by other trades shall be delivered to the site in sufficient time to avoid delays to construction progress. Instruct other trades concerning the location and placement of reglets, wood nailers, and cleats.

D. Surfaces to which roofing and sheet metal are to be applied shall be even, smooth, sound, thoroughly clean and dry and free from projecting nail heads or other defects that would affect the application. Report in writing any unsatisfactory surfaces to the Architect.

E. Where flashing abuts or members into adjacent dissimilar metals, the juncture shall be executed in a manner that will facilitate drainage and thus minimize the possibility of galvanic action.

F. All accessories or other items essential to the completeness of the sheet metal installation, though not specifically shown or specified, shall be provided. All such items, unless otherwise indicated on Drawings or specified, shall be of the same kind of material as the item to which applied and the gauges shall conform to recognized industry standards of sheet metal practice.

G. Provide expansion joints in sheet metal work at intervals not greater than forty (40′) feet. Expansion joints shall be fabricated in accordance with the recommendations of the Architectural Sheet Metal Manual (SMACNA) and as specified herein.

H. Fabricate and install sheet metal with lines, arises, and angles sharp and true and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form a 1/2″ wide hem on the side concealed from water leakage under all weather conditions. The workmanship and methods employed for framing, anchoring, cleating, and the expansion and contraction of sheet metal work shall conform to applicable details and description as indicated in current edition of the following publications unless other methods are indicated on project Drawings or specified herein.

1. Architectural Sheet Metal Manual as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., and hereinafter referred to as "The SMACNA Manual".

2. Handbook of Sheet Copper Fundamentals, Design, Details and Specifications as published by Copper Development Association, Inc., latest Edition.

I. All ferrous metal work shall be zinc coated and finished as specified elsewhere herein. Touch-up all field cuts and minor scratches with approved zinc rich primer and finish coat to match adjacent finishes.

J. All metal work terminating on roofing shall be provided with flanges for nailing. Wood nailers shall be provided beneath flanges and roofing for nailing of the metal flanges.

K. Provide cleats, edge and drip strips where sheet metal extends over edges and where necessary to secure sheet metal work at fascias, and elsewhere. Form edge strips in lengths of 8′ or 10′. The ends shall be butted together, leaving approximately 1/4″ space for expansion. Secure to building construction with fasteners spaced not over 12″ on centers. Install strips in continuous, long lengths to allow metal work to be hooked over lower edge at least 1/2″.

L. Flash intersections of roofs with vertical surfaces as detailed and indicated on the Drawings, or otherwise required to provide watertight construction and to suit job conditions.

3.10 METALWORK EXPANSION JOINTS

A. Provide expansion joints at forty (40′) feet maximum intervals and at all building movement joints.

B. Begin expansion joint construction by setting eight (8″) inch wide brakemetal base sheet/cleat.

C. Lap ends of gravelstops, fascias, or other metal work over base sheet, leaving approximately one-half (1/2″) inch clear space between butt ends. Set each end in full bed of roofing cement.

END OF ROOFING AND FLASHING

SECTION 07 54 00
THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adhered thermoplastic roofing membrane system including flat and tapered insulation, vapor retarder, deck sheathing (as required to match existing, if any) .

D. Metal flashings and fascia related to membrane roofing under the total system warranty are specified in Section 07 62 00 - Sheet Metal Flashing and Trim.

E. Roofing stack boots, roofing expansion joints, and walkway pads.

1.02 RELATED REQUIREMENTS

A. Section 02 41 00 - Demolition: Removal of the existing roofing system.

B. Section 06 10 54 - Wood Blocking and Curbing: Wood nailers, blocking, cants.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Metalwork fascias, copings, counterflashings.

D. Division 23 - HVAC: Roof mounted equipment.

1.03 REFERENCE STANDARDS

A. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2014.

B. ASTM D6878 - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2011a.

C. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials; 2010.

D. FM DS 1-28 - Wind Design; Factory Mutual Research Corporation; 2007.

E. ITS - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

F. NRCA - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.

G. UL - Roofing Materials and Systems Directory; Underwriters Laboratories Inc.; current edition.

H. UL - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Convene at least two weeks before starting work of this Section, after the submission and review of roofing and flashing shop drawings, samples and printed data. Review preparation and installation procedures, coordination and scheduling necessary for related work, determine access, staging and storage areas, establish working weather conditions, roofing protection provisions, considerations for safety of building occupants and other relevant issues.
   1. Review preparation and installation procedures and coordinating and scheduling required with related work.
   2. The following personnel shall be present:
      a. Contractor (Project Manager, Superintendent)
      b. Roofing Sub-Contractor (Project Manager, Foreman)
      c. Roofing and Flashing Materials Manufacturers
      d. Mechanical Sub-Contractor (Project Manager, Foreman)
      e. Architect, Project Manager and Owner's Representative
   3. Verify compatibility of all materials in contact with roofing, including but not limited to:
      a. Treated lumber.
      b. Sealants and adhesives.
      c. Thru wall flashing

d. Insulations and roofing boards.
e. Vapor Retarders.
f. Walkway pads.
g. All other roofing materials.

1.05 SUBMITTALS

A. See Section 01 30 00 - Submittals, for submittal procedures.

B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners.

C. Specimen Warranty: For approval.

D. Shop Drawings: Roof details and roof plan.
1. Indicate joint or termination detail conditions and conditions of interface with other materials.
2. Indicate tapered insulation thicknesses, slopes and layout. Key-in details on roof layout plan.
3. Indicate roof mounted equipment, penetrations, etc. on roof plan.
4. Indicate expansion joint details and locations; curb and fascia details; joint or termination detail conditions, conditions of interface with other materials, and roof traffic pad layout. Key-in details on roof layout plan.

E. Samples:
1. Submit samples 6x6 inches in size illustrating insulation, membrane, underlayments, overlayments.

F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

H. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, supplementary instructions given, and acceptance of substrate.

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

1.06 QUALITY ASSURANCE

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum twenty years of documented experience.

C. Installer Qualifications: Company specializing in performing the work of this Section:
1. With minimum ten years documented experience.
2. Approved by membrane manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

B. Store products in weather protected environment, clear of ground and moisture.

C. Protect foam insulation from direct exposure to sunlight.

1.08 FIELD CONDITIONS

A. Do not apply roofing membrane during unsuitable weather.

B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY

A. See Section 01 78 10 - Warranties, for additional warranty requirements.

B. Applicator/Contractor Warranty: The roofing subcontractor hereby guarantees that all roofing items not covered by the roofing manufacturer's total system warranty shall be free from defective materials and workmanship for a period of three (3) years from the date of Substantial Completion. Upon notification of any such defects within said guarantee period the roofing subcontractor shall promptly make all necessary repairs and replacements at no cost or expense to the Owner. This warranty shall be signed and countersigned by the installer (Roofer) and the Contractor.

C. Manufacturer's Total System Warranty: Roofing materials manufacturer shall furnish the Owner a "Total System" warranty insuring a watertight roof for a period of twenty (20) years. The warranty shall cover all repairs necessary over the period up to the original cost of the original roofing contract. Warranty shall include maximum peak gust wind speed coverage of up to 55 mph.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermoplastic Polyolefin (TPO) Membrane Materials:
   1. Sure-Weld TPO by Carlisle SynTec.
   2. UltraPly TPO by Firestone Building Products Co.
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: As approved by roofing system manufacturer.

C. Manufacturer of insulation, fasteners, polmeric components, edgings and other accessories or components required to complete the specified system: Same manufacturer as roof membrane or accepted by the manufacturer as compatible.

2.02 ROOFING - GENERAL

A. Roofing System: Listed in order from top down.
   1. Fully adhered TPO membrane roofing system.
   2. Polyisocyanurate foam board insulation, adhered.
      a. Minimum R Value: R-20 in a two layer installation with staggered joints.
      b. Tapered: (where required) Slope as indicated, 1/4 inch minimum pitch; locate under flat boards.
   3. Vapor retarder
   4. Concrete roof deck.

B. Assembly Requirements:
   1. Roof Covering External Fire-Resistance Classification: UL Class A.
   2. Factory Mutual Classification: Class I and windstorm resistance of I-90, in accordance with FM DS 1-28.

C. Wind Load: See Structural Drawings.
   1. Design Wind Speed (3 second gust): 95 mph.
   2. Wind Exposure: C
   3. Importance Factor (wind): 1.15
   4. Roof Pressures, interior zone: +13.2 / -23.2 PSF
   5. Roof Pressures, exterior zone: +13.2 / -23.2 PSF

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Roofing Membrane: ASTM D 6878; Thermoplastic polyolefin, scrim reinforced.
   1. Reinforcing: Fiberglass reinforced membrane with factory 9 oz. feltback fabric backing.
   2. Thickness: 0.060 inch, minimum.
   3. Sheet Width: Factory fabricated into largest sheets possible.
   4. Color: To be selected by Architect from manufacturer's full standard color range.

B. Seaming Materials: Heat welded, As recommended by membrane manufacturer.

C. Membrane Flashing: 0.060 inch thickness membrane, color matching.

D. Fasteners: As recommended and approved by membrane manufacturer.

E. Air and Vapor Barrier: Adhered membrane material approved by roof manufacturer complying with requirements of fire rating classification; compatible with roofing and insulation materials.
   1. Fire-retardant adhesive.
   2. Vapor Permeability, ASTM E96: 0.02 perm.
   3. Air Permeability, E2178: 0.001 $ft^3/min \cdot ft^2$
   4. Product:
      a. VapAir Seal 725TR Air and Vapor Barrier by Carlisle.
      b. V-Force Vapor Barrier Membrane by Firestone.

2.04 INSULATION

A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type II, Class 2, polymer bonded glass fiber mat both faces and with the following characteristics:
   1. Compressive Strength: 20 psi
   2. Total R Value: 20 minimum.
   3. Tapered Board: Slope as indicated; fabricate with taper of 1/4 inch per foot minimum. All roof drains shall be sumped in a 4' x 4' area.
   4. Long Term Thermal Resistance: Minimum R-value of 5.6 per inch min.
   5. Board Edges: Square.
   6. Manufacturer: As recommended by the roofing system manufacturer.

2.05 ACCESSORIES

A. Roofing Expansion Joint: Roofing manufacturer's standard detail with tubular foam, support membrane and cover membrane.

B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.

C. Adhesive: As recommended by the roofing system manufacturer.

D. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.

E. Thinners and Cleaners: As recommended by the roofing system manufacturer, compatible with membrane.

F. Sealants: As recommended by the roofing system manufacturer.

G. Walkway Pads: 30" x 30", non-slip, type as recommended by the roofing system manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION – GENERAL

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

B. Do not apply roofing membrane during unsuitable weather.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.02 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. The Owner shall confirm moisture content of concrete roof slab is acceptable for roofing installation by moisture testing completed prior to start of the Work.

F. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.03 VAPOR RETARDER AND INSULATION INSTALLATION

A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Extend vapor retarder under blocking to deck edge.
   2. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

C. Attachment of Insulation: Install insulation over substrate with boards butted tightly together with no joints or gaps greater than 1/4 inch. Stagger joints both horizontally and vertically for multiple insulation layers. Adhere insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.

D. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.

E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

F. Do not apply more insulation than can be covered with membrane in same day.

3.04 MEMBRANE APPLICATION

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Fully Adhered Application: Apply adhesive to substrate at rate recommended by manufacturer to meet requirements. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.

F. Around roof penetrations, seal flanges and flashings with flexible flashing.

G. Coordinate installation of roof drains and sumps and related flashings.

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 10 - Testing, for general requirements for field quality control and inspection.

B. Require site attendance of roofing material manufacturer’s representative during installation of the Work and upon completion of the installation, to ascertain that the roofing system has been installed according to the roofing system manufacturer's published specifications and details.
   1. Submit a copy of the roofing system manufacturer's representative's field report to the Architect and Contractor.
   2. Make all corrections recommended by the manufacturer.
   3. Provide all required documents to the roofing materials manufacturer as required for issuance of the specified warranty.

3.06 CLEANING

A. Remove bituminous markings from finished surfaces.

B. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.07 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including flashings and counterflashings.

B. Sealants for joints within sheet metal fabrications.

C. Fabricated sheet metal fascias, copings, drip edges, and cleats.

D. Reglets and accessories.

1.02 RELATED REQUIREMENTS

A. Section 06 10 54 - Wood Blocking and Curbing: Wood blocking for metal flashings.

B. Section 07 54 00 - Thermoplastic Membrane Roofing: Membrane roofing system requiring metalwork for Total System warranty.

1.03 REFERENCE STANDARDS

A. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2013.

B. ANSI/SPRI ES-1.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2010.

D. SMACNA - Architectural Sheet Metal Manual; 2012.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meeting: Conveneat least two weeks before starting work of this Section.

1.05 PERFORMANCE REQUIREMENTS

A. General: Install flashings that are watertight; will not permit the passage of liquid water; and will withstand wind loads, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

1.06 SUBMITTALS

A. See Section 01 30 00 - Submittals, for submittal procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details. Key into roof plan shop drawing, see roofing Section.

C. Samples:
   1. Submit samples each 4x4 inch in size, illustrating metal materials, thickness, and colors.
   2. Submit samples 8" long in size, illustrating roofing fascia system.

1.07 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA 1793 and CDA A4050 requirements and standard details, except as otherwise indicated.

B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with ten years of documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

1.09 WARRANTY

A. The flashing and roofing subcontractor hereby guarantees that roof metalwork, flashings, roofing, roof insulation and roof accessories will be free from defective materials and workmanship for a period of three (3) years from the date of Substantial Completion. Upon notification of any such defects within said guarantee period the roofing and flashing subcontractor shall promptly make all necessary repairs and replacements at no cost or expense to the Owner. This warranty shall be signed and countersigned by the installer (Roofer) and the Contractor.

B. Metal Flashings Warranty under Roofing Manufacturer's Total System Warranty: See Section 07 54 00 - Thermoplastic Membrane Roofing.

C. Pre-finished Aluminum: Finish shall be warranted against premature failure for twenty (20) years.

PART 2 PRODUCTS

2.01 MATERIALS

A. Membrane Roofing Fascia System: Aluminum. Color match existing.
   1. Product: As approved by the selected roofing system manufacturer for a Total System Warranty. Examples include: SecurEdge 2000 as manufactured by Carlisle Syn-Tec, Anchor-tite by Metal-era.
   2. Extruded anchor bar / cleat: 0.100 inch.
   3. Fascia: 0.040 inch.
   4. Accessories: As recommended by the system manufacturer.
   5. Fasteners: Anchors with rubber washers as recommended by the system manufacturer.
   6. Sealant: Non-curing as recommended by the system manufacturer.

B. Pre-Finished Aluminum: ASTM B209; factory pre-coated with fluoropolymer coating.
   1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; Kynar or Duranar by PPG.
   2. Color: Match existing.
   3. For Total System Warranty projects, metalwork shall be as approved by the membrane roofing manufacturer.

2.02 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.

B. Primer: Zinc chromate type. Confirm primer compatibility with sub-surface component manufacturer.

C. Sealant to be Concealed in Completed Work: Non-curing butyl sealant as recommended by manufacturer.

D. Plastic Cement: ASTM D4586, Type I.

E. Reglets: Surface mounted type, galvanized steel; face and ends covered with plastic tape.

F. Fasteners for Aluminum: Stainless steel ring nails; 12 gage with 1/4" diameter, flat head, annular threaded, needle point, length as required to obtain 1-1/4" embedment into blocking/framing and full depth into plywood.

G. Sealant: Silicone, as recommended by manufacturer. Use for aluminum flashing joint seal.

H. Isolation Strips; See Section 06 10 54 Wood Blocking and Curbing.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.. Form on a bending brake. Perform shaping, trimming, and hand seaming in the shop to the maximum extent possible.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch; miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams. Form metal with full regard for expansion and contraction to avoid buckling or other deformation in service. All lines and arrisses shall be straight and crisp except where thickness of metal dictates radius bend.

E. Pre-fabricate corners with joints locked, riveted and soldered watertight, and where indicated from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.

F. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

G. Unless indicated otherwise, provide expansion joints at 24 feet on centers maximum and at 2 feet from all changes in flashing direction (each side) and from all terminations of flashing.

H. Fabricate cleats in continuous lengths.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Install surface mounted reglets true to lines and levels. Seal top of reglets with sealant.

3.03 GENERAL REQUIREMENTS FOR METAL FLASHING

A. Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather, without failing. Fabricate and install flashings and roof edges to fully comply with the recommendations of Factory Mutual (FM) Loss Prevention Data Sheet 1-49 for the applicable wind zone.

1. All low-slope membrane roof system metal edge securement shall be designed and installed for required wind loads and tested per ANSI/SPRI ES-1.

B. Schedule and coordinate sheet metal installations with the work of other trades where it is integral or continuous therewith. Materials furnished under this Section that are to be built-in by other trades shall be delivered to the site in sufficient time to avoid delays to construction progress. Instruct other trades concerning the location and placement of reglets, wood nailers, and cleats.

C. Surfaces to which roofing and sheet metal are to be applied shall be even, smooth, sound, thoroughly clean and dry and free from projecting nail heads or other defects that would affect the application. Report in writing any unsatisfactory surfaces to the Contractor.

D. Where flashing abuts or members into adjacent dissimilar metals, the juncture shall be executed in a manner that will facilitate drainage and thus minimize the possibility of galvanic action. Note: All metalwork shall be isolated from contact with pressure treated wood products, using roofing membrane, felts, or approved coatings.

E. All accessories or other items essential to the completeness of the sheet metal installation, though not specifically shown or specified, shall be provided. All such items, unless otherwise indicated on Drawings or specified, shall be of the same kind of material as the item to which applied and the gauges shall conform to recognized industry standards of sheet metal practice.

F. Provide expansion joints in sheet metal work at intervals not greater than forty (40') feet. Expansion joints shall be fabricated in accordance with the recommendations of the Architectural Sheet Metal Manual (SMACNA) and as specified herein.

1. Begin expansion joint construction by setting an 8" wide cleat. Lapp ends of metal work over base sheet, leaving 1/2" clear space between butt ends. Set ends in full bed of

sealant. Cover entire joint assembly with a 4 inch wide metal cover, finish to match other metal work and secured allowing for movement.

G. Fabricate and install sheet metal with lines, arises, and angles sharp and true and plane surfaces free from objectionable wave, warp, or buckle. Exposed edges of sheet metal shall be folded back to form a 1/2" wide hem on the side concealed from water leakage under all weather conditions. The workmanship and methods employed for framing, anchoring, cleating, and the expansion and contraction of sheet metal work shall conform to applicable details and description as indicated in current edition of the following publications unless other methods are indicated on project Drawings or specified herein.
   1. Architectural Sheet Metal Manual as published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., and hereinafter referred to as "The SMACNA Manual".

H. All metal work terminating on roofing shall be provided with flanges for nailing. Wood nailers shall be provided beneath flanges and roofing for nailing of the metal flanges.

I. Provide cleats, edge and drip strips where sheet metal extends over edges and where necessary to secure sheet metal work at fascias, and elsewhere. Form edge strips in lengths of 8' or 10'. The ends shall be butted together, leaving approximately 1/4" space for expansion. Secure to building construction with fasteners spaced not over 12" on centers. Install strips in continuous, long lengths to allow metal work to be hooked over lower edge at least 1/2".

J. Flash intersections of roofs with vertical surfaces as detailed and indicated on the Drawings, or otherwise required to provide watertight construction and to suit job conditions.

K. Seams shall always be made in direction of flow.

L. Fabricated fascias shall be sized and shaped to profiles indicated, using sheets 8' to 10' long. Lower edge shall hook a minimum of 1/2" over previously placed continuous edge cleats.

3.04 INSTALLATION

A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal metal joints watertight.

3.05 INSTALLATION OF TOTAL SYSTEM ROOFING METALWORK

A. Confirm that roofing membrane shall extend over face of perimeter blocking and weatherbarrier transition membrane for wall / eave construction.

B. Set anchor cleat in a continuous bead of sealant and secure with recommended fasteners.

C. At end joints and corners of anchor cleat, install manufacturer's rubber splice material to maintain a continuous seal providing a watertight edge.

D. Install fascia on the anchor cleat in accordance with manufacturer's recommendations.

3.06 SCHEDULE FOR FABRICATED METALWORK

A. Cleats: Aluminum, 0.050 inch.

B. Base Flashing: Aluminum: 0.040 inch.

C. Coping, Cap, Parapet, Sill and Ledge Flashings: Aluminum, 0.040 inch.

D. Miscellaneous Flashings: Aluminum: 0.040 inch or as required, unless otherwise indicated on Drawings.

3.07 FIELD QUALITY CONTROL

A. See Section 01 40 10 - Testing, for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

C. See Section 07 54 00 – Thermoplastic Membrane Roofing, for field inspection requirements.

3.07 CLEANING AND PROTECTION

A. Clean all metalwork to remove all fingerprints, oils, etc.

B. Remove from roof surfaces all scraps and metal debris immediately. Extreme care shall be exercised to prevent sharp metal scraps or waste nails from coming into contact with membrane materials.

END OF SECTION