

Project Manual

for

Cunningham Middle School and North Shore Middle School

BEAM Project No.: 250373

Galena Park Project No.: B108

for the

GALENA PARK INDEPENDENT SCHOOL DISTRICT

December 05, 2025

Issue for Proposal

Volume 1

Board of Trustees

Ramon Garza
Linda Clark Sherrard
Jose Jimenez
Adrian Stephens
Noe Esparza
Norma Hernandez
Amanda Erebia
Dr. John C. Moore

President
Vice President
Secretary
Board Trustee
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Superintendent

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Team

Architecture

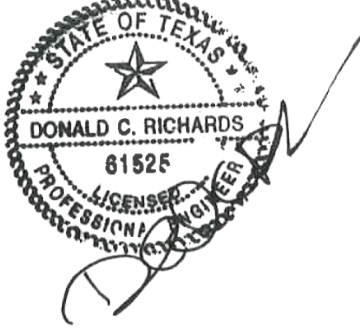
BEAM Professionals
11 Greenway Plaza Blvd
Houston, Texas 77046
Phone: (713) 940-3201

MEP

LEAF Engineers
11 Greenway Plaza Blvd, 15th Floor
Houston, Texas 77046
Phone: (713) 940-3300

Issue for Construction

Each specification section included herein is listed in the Project Manual Table of Contents with a letter code, indicated below, designating the Designer of Record responsible for its preparation, under whose seal and/or authority it is issued for the purpose(s) stated above. Seals and signatures do not apply to documents not included herein, nor (except as otherwise indicated) to documents prepared by the Owner or others ("O"), including but not necessarily limited to documents in Division 00, geotechnical and other reports, etc.

Engineer of Record, Mechanical: Mital J. Patel, P.E. P.E. #111622	 12/05/2025	LEAF Engineers 11 Greenway Plaza Blvd, 15th Floor Houston, Texas 77046 Phone: (713) 940-3300
Engineer of Record, Electrical, Plumbing & Technology: Donald C. Richards, P.E. P.E. #61525	 12/05/2025	LEAF Engineers 11 Greenway Plaza Blvd, 15th Floor Houston, Texas 77046 Phone: (713) 940-3300

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DOCUMENT 00 31 00 - AFFIDAVIT OF NON-ASBESTOS, LEAD, AND PCB USE IN PROJECT

Upon completion of this form, return to the Architect upon close-out of the project.

PROJECT:
Cunningham MS (Roof & HVAC)
14110 Wallisville Rd.
Houston, Texas 77049

ARCHITECT:
BEAM Professionals
11 Greenway Plaza, 22nd Floor
Houston, Texas 77046

North Shore Middle School
120 Castlegory Rd
Houston, Texas 77015

ARCHITECT'S PROJECT NO. 25037301

CONTRACTOR: _____

DATE: _____

(Name, address)

AFFIDAVIT

The undersigned affirms and certifies that "to the best of their knowledge and belief asbestos, lead, and PCB containing materials have not been used or incorporated into the Work and lead or lead bearing materials have not been incorporated into potable water systems", including, but not limited to those water systems for drinking fountains, all sinks, showers, bath tubs, residential and commercial kitchen equipment, ice machines, and hose bibbs, as applicable to the project, and that lead sheet flashing used in through roof plumbing penetration applications is the only lead on the Project.

Company

Printed Name

Signature

STATE OF TEXAS)
)
COUNTY OF _____)

Sworn to and subscribed before me at _____, Texas, this the _____ day of _____, 20__.

Notary Public in and for _____ County, Texas

END OF DOCUMENT 00 31 00

NOTE: THIS DOCUMENT MUST BE EXECUTED AND SUBMITTED AT PROJECT CLOSE-OUT



Important Dates
 August 12 First Day of School
 May 22 Last Day of School

New Teacher Orientation
 July 29 - August 1

Student Holiday/Staff Development
 August 4 - 11, 29 September 19
 October 14 November 3, 4
 January 5 February 13
 March 6 April 2

Early Dismissal All Campuses
 December 19 May 22

Holidays
 July 4 September 1
 October 10 - 13 November 24 - 28
 Dec. 22 - Jan. 2 January 19
 February 16 March 9 - 13
 April 3 - 6 May 25
 June 19

July 2025	August 2025	September 2025	October 2025
S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
November 2025	December 2025	January 2026	February 2026
S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
March 2026	April 2026	May 2026	June 2026
S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31	S M T W T F S 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

LEGEND ○ Student Holiday/Staff Development
 ■ District Holidays
 ■ School Holidays, except for EOC Testing
 ○ New Teacher Orientation ○ Early Dismissal - All Campuses

SCHOOL HOURS
 Elementary School 7:35 am - 3:15 pm
 Middle School 8:20 am - 4:00 pm
 High School 7:05 am - 2:45 pm
 Early College High School 8:00 am - 4:15 pm
 Zotz Education Center 8:15 am - 3:55 pm

Six Weeks Grading Period	Report Card Dates	Nine Weeks Grading Period	Report Card Dates	State Testing Days
High Schools		Elementary/Middle Schools		
First Semester		First Semester		December 2 - 12
1. Aug. 12 - Sept. 18 (26 days)	Sept. 26	1. Aug. 12 - Oct. 9 (39 days)	Oct. 17	April 7 - April 24
2. Sept. 22 - Oct. 31 (27 days)	Nov. 7	2. Oct. 15 - Dec. 19 (42 days)	Jan. 9	May 4 - May 15
3. Nov. 5 - Dec. 19 (28 days)	Jan. 9			June 17 - 20
Second Semester		Second Semester		End of Course Testing
4. Jan. 6 - Feb. 12 (27 days)	Feb. 20	3. Jan. 6 - Mar. 5 (40 days)	Mar. 20	STAAR/End of Course
5. Feb. 17 - Apr. 1 (26 days)	Apr. 10	4. Mar. 16 - May 22 (47 days)	May 26 ES/May 29 MS	Dual Credit Finals/AP Testing
6. Apr. 7 - May 22 (34 days)	June 4			STAAR/End of Course Retest
				(Subject to change if needed)

Prevailing Wage Rate Determination Information

The following information is from Chapter 2258 Texas Government Code:

Sec. 2258.021. Right to be Paid Prevailing Wage Rates.

- (a) A worker employed on a public work by or on behalf of the state or a political subdivision of the state shall be paid:
 - (1) not less than the general prevailing rate of per diem wages for work of a similar character in the locality in which the work is performed; and
 - (2) not less than the general prevailing rate of per diem wages for legal holiday and overtime work.
- (b) Subsection (a) does not apply to maintenance work.
- (c) A worker is employed on a public work for the purposes of this section if the worker is employed by a contractor or subcontractor in the execution of a contract for the public work with the state, a political subdivision of the state, or any officer or public body of the state or a political subdivision of the state.

Sec. 2258.023. Prevailing Wage Rates to be paid by Contractor and Subcontractor; Penalty.

- (a) The contractor who is awarded a contract by a public body or a subcontractor of the contractor shall pay not less than the rates determined under Section [2258.022](#) to a worker employed by it in the execution of the contract.
- (b) A contractor or subcontractor who violates this section shall pay to the state or a political subdivision of the state on whose behalf the contract is made, \$60 for each worker employed for each calendar day or part of the day that the worker is paid less than the wage rates stipulated in the contract. A public body awarding a contract shall specify this penalty in the contract.
- (c) A contractor or subcontractor does not violate this section if a public body awarding a contract does not determine the prevailing wage rates and specify the rates in the contract as provided by Section [2258.022](#).
- (d) The public body shall use any money collected under this section to offset the costs incurred in the administration of this chapter.
- (e) A municipality is entitled to collect a penalty under this section only if the municipality has a population of more than 10,000.

Sec. 2258.051. Duty of Public Body to Hear Complaints and Withhold Payment.

A public body awarding a contract, and an agent or officer of the public body, shall:

- (1) take cognizance of complaints of all violations of this chapter committed in the execution of the contract; and
- (2) withhold money forfeited or required to be withheld under this chapter from the payments to the contractor under the contract, except that the public body may not withhold money from other than the final payment without a determination by the public body that there is good cause to believe that the contractor has violated this chapter.

Prevailing Wage Rates – School Construction Trades

June 2, 2025

Texas Gulf Coast Area

CLASSIFICATION	2025 HOURLY RATE
ASBESTOS WORKER	\$27.20
BRICKLAYER; MASON	\$24.90
CARPENTER; CASEWORKER	\$23.13
CARPET LAYER; FLOOR INSTALLER	\$26.20
CONCRETE FINISHER	\$23.83
DATA COMM/TELE COMM	\$24.33
DRYWALL INSTALLER; CEILING INSTALLER	\$24.33
ELECTRICIAN	\$29.86
ELEVATOR MECHANIC	\$39.78
FIREPROOFING INSTALLER	\$22.99
GLAZIER	\$23.25
HEAVY EQUIPMENT OPERATOR	\$22.17
INSULATOR	\$21.95
IRONWORKER	\$26.50
LABORER, HELPER	\$19.81
LATHERER; PLASTERER	\$22.75
LIGHT EQUIPMENT OPERATOR	\$28.75
METAL BUILDING ASSEMBLER	\$24.00
PAINTER; WALL COVERING INSTALLER	\$20.17
PIPEFITTER	\$29.82
PLUMBER	\$27.98
ROOFER	\$22.50
SHEET METAL WORKER	\$29.96
SPRINKLER FITTER	\$23.00
STEEL ERECTOR	\$26.00
TERRAZZO WORKER	\$22.75
TILE SETTER	\$22.00
WATERPROOFER; CAULKER	\$24.00

This document was developed by PBK Architects, Inc., in strict accordance with Chapter 2258 of the Texas Government Code.

Prevailing Wage Rates

Worker Classification Definition Sheet

CLASSIFICATION	DEFINITION
ASBESTOS WORKER	Worker who removes and disposes of asbestos materials.
BRICKLAYER; MASON	Craftsman who works with masonry products, stone, brick, block, or any material substituting those materials and accessories.
CARPENTER; CASEWORKER	Worker who build wood structures or structures of any material which has replaces wood. Includes rough and finish carpentry, hardware and trim.
CARPET LAYER; FLOOR INSTALLER	Worker who installs carpets and /or floor coverings, vinyl tile.
CONCRETE FINISHER	Worker who floats, trowels, and finishes concrete.
DATA COMM/TELE COMM	Worker who installs data/telephone and television cable and associate equipment and accessories.
DRYWALL; CEILING INSTALLER	Worker who installs metal framed walls and ceiling, drywall coverings, ceiling grids, and ceilings.
ELECTRICIAN	Skilled craftsman who installs or repairs electrical wiring and devices. Includes fire alarm systems and HVAC electrical controls.
ELEVATOR MECHANIC	Craftsman skilled in the installation and maintenance of elevators.
FIREPROOFING INSTALLER	Worker who sprays or applies fire proofing materials.
GLAZIER	Worker who installs glass, glazing, and glass framing.
HEAVY EQUIPMENT OPERATOR	Includes but not limited to: all CAT tractors, all derrick-powered, all power operated cranes, back-hoes, back-fillers, power operated shovels, winch trucks, and all trenching machines.
INSULATOR	Worker who applies, sprays, or installs insulation.
IRONWORKER	Skilled craftsman who erects structural steel framing, and installs structural concrete Rebar.
LABORER, HELPER	Worker qualified for only unskilled or semi-skilled work. Lifting, carrying materials or tools, hauling, digging, clean up.
LATHERER; PLASTERER	Worker who installs metal framing and lath. Worker who applies plaster to lathing and installs associated accessories.
LIGHT EQUIPMENT OPERATOR	Includes but not limited to , air compressors, truck crane drivers, flex planes, building elevators, form graders, concrete mixers less than 14cf), conveyers.
METAL BUILDING ASSEMBLER	Worker who assembles pre-made metal buildings.
PAINTER; WALL COVERING INSTALLER	Worker who prepares wall surfaces and applies paint and/or wall coverings, tape, and bedding.
PIPEFITTER	Trained worker who installs piping systems, chilled water piping and hot water (boiler) piping, pneumatic tubing controls, chillers, boilers, and associated mechanical equipment.
PLUMBER	Skilled craftsman who installs domestic hot and cold water piping, waste piping, storm system piping, water closets, sinks, urinals, and related work.
ROOFER	Worker who installs roofing materials, Bitumen (asphalt and coal tar) felts, flashings, all types of roofing membranes, and associated products.
SHEET METAL WORKER	Worker who installs sheet metal products, Roof metal, flashings and curbs, ductwork, mechanical equipment, and associated metals.
SPRINKLER FITTER	Worker who installs fire sprinklers systems and fire protectant equipment.
STEEL ERECTOR	Worker who erects and dismantles structural steel frames of buildings and other structures.
TERRAZZO WORKER	Craftsman who places and finishes Terrazzo
TILE SETTER	Worker who prepares wall and/or floor surfaces and applies ceramic tiles to these surfaces.
WATERPROOFER; CAULKER	Worker who applies water proofing material to buildings. Products include sealant, caulk, sheet membranes, and liquid membranes, sprayed, rolled or brushed.

SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Project information.
 - 2. Work covered by Contract Documents.
 - 3. Phased construction.
 - 4. Work by Owner.
 - 5. Work under separate contracts.
 - 6. Purchase contracts.
 - 7. Owner furnished products.
 - 8. Owner furnished, Contractor installed products.
 - 9. Access to site.
 - 10. Coordination with occupants.
 - 11. Work restrictions.
 - 12. Specification and drawing conventions.
 - 13. Miscellaneous provisions.

1.3 PROJECT INFORMATION

- A. Project Identification and Location:
 - 1. Cunningham Middle School: 14110 Wallisville Road, Houston, TX 77049
 - 2. North Shore Middle School: 120 Castlegory, Houston, TX 77409
- B. Owner: Galena Park Independent School District
 - 1. Owner's Representative: Edgardo Martir, Director of Facility Planning & Construction
- C. Architect: BEAM Professionals.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:

North Shore Middle School

North Shore MS Roof Restoration

- 1. Install a flute fill ISO, Cover board and 60 mil. Felt back PVC Roof system with décor ribs to simulate standing seam to qualify for a 20yr NDL warranty.
- 2. New Gutter and Downspout.
- 3. New nailer associated sheet metal and roof components.
- 4. Minor repairs to coping cap at low slope roof areas.

Cunningham Middle School

Recover: A1,A2,A3,B1,B2,B3,C2,C5,C6,C7,C8

1. Spud, vacuum and remove aggregate from in place roof system. Down to a bondable and smooth surface.
2. Install 2x6 nailers at perimeter to match insulation height
3. Set 1.5" high density insulation in adhesive at roof areas.
4. Set tapered insulation and crickets in adhesive to provide positive drainage to drains.
5. Install ½" DensDek prime set-in adhesive.
6. Install sheet metal components
7. Install a 2-ply modified bitumen roof system to qualify for a 20-year warranty.
8. New gutter and downspout as shown in contract documents.
9. Remove sealants from control and soft joints at exterior walls, grind joints clean, install backer rod and sealant.

Reroof: C1,C2,C3,C9,C10

1. Remove existing roof system down to metal or concrete deck.
 2. Install 2 layers of 2.2 Polyisocyanurate. See details for attachment.
 3. Install taper insulation and crickets.
 4. Install ½" DensDek prime set-in adhesive.
 5. Install 2x6 nailer at perimeter, match insulation height.
 6. Install sheet metal components.
 7. install a 2-ply modified bitumen roof system to qualify for a 20-year warranty.
 8. All roof areas, verify gas line use and remove not in use.
 9. Remove abandoned skylight curb and cover. Repair deck per contract documents.
 10. New gutter and downspout as shown in contract documents.
- HVAC Upgrades

The Work of Project is defined by the Contract Documents and consists of the following: R placement of 4 AHU's, replacement of 4 condensing units, refurbishing 4 AHU's, replacement of all VFD's, replacement of 6 chilled water primary and secondary pumps, and condensing water pumps , replacement of controls throughout the entire building.

- B. Work to be provided with complete work systems per manufacturer's minimum instructions as recommended by manufacturer.
- C. Type of Contract: Project will be constructed under a competitive sealed proposal (CSP) contract.

1.5 WORK BY OWNER AND UNDER SEPARATE CONTRACTS

- A. Cooperate fully with Owner so Work may be carried out smoothly, without interfering with or delaying the work or work by Owner. Coordinate the Work with Work performed by Owner.
- B. The Owner reserves the right to let separate contract for Work outside of the scope of this Contract. Cooperate fully with separate contractors so Work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with Work performed under separate contracts.
- C. Purchase Contracts: The Owner reserves the right to negotiate purchase contracts with suppliers of material and equipment that may be incorporated into the Work. The Owner will assign these purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum, unless otherwise indicated.

1. Contractor's responsibilities are same as if Contractor had negotiated purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.
- D. Owner Furnished, Contractor Installed Products (OFCI): The Owner will furnish products indicated. The Work includes receiving, unloading, handling, storing, protecting, and installing Owner furnished products and making building services connections when applicable.
 1. Owner Furnished Products: Coordinate with Owner.

1.6 ACCESS TO SITE

- A. Use of Site: Limit use of Project site to Work in areas and areas within the Contract limits indicated. Do not disturb portions of site beyond areas in which the Work is indicated.
 1. Limits: The drawings indicate the limits of the construction operations.
 2. Driveways, Walkways, and Entrances: Keep driveways, parking areas, student drop off and pick up points, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, the students, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
 - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Condition of Existing Building: Maintain portions of existing building affected by construction operations in weathertight condition throughout construction period. Repair damage caused by construction operations.

1.7 COORDINATION WITH OCCUPANTS

- A. Full Owner Occupancy: Owner will occupy site and adjacent building(s) during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform Work to prevent interference with Owner's day to day operations. Maintain existing means of egress unless otherwise indicated.
 1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 2. Notify Owner not less than 72 hours in advance of activities that will affect Owner's operations.
- B. Owner Limited Occupancy of Completed Areas of Construction: Owner reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.
 1. Architect will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Owner acceptance of the completed Work.
 2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Owner occupancy.
 3. Before limited Owner occupancy, ensure mechanical and electrical systems are fully operational, and required tests and inspections and start up procedures are successfully completed. On occupancy, Owner will operate and maintain mechanical and electrical systems serving occupied portions of Work.
 4. Upon occupancy, Owner will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.8 WORK RESTRICTIONS

- A. Work Restrictions: Comply with restrictions on construction operations. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On Site Work Hours: Limit Work in the existing building to normal working hours, Monday through Friday, unless otherwise indicated. Coordinate with Owner when it is necessary to extend working hours or work on weekends.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and after providing temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than two weeks in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.
 - 1. Notify Owner not less than two weeks in advance of proposed disruptive operations.
 - 2. Obtain Owner's written permission before proceeding with disruptive operations.
- E. Controlled Substances, Firearms, and Explosive Devices: Use of tobacco products, controlled substances, firearms, and explosive devices on the site is not permitted.
- F. Employee Identification: Provide identification tags for Contractor personnel working on site. Require personnel to use identification tags at all times. Finger printed and badged.
- G. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on site.
 - 1. Maintain list of approved screened personnel with Owner's representative.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in situations. These conventions are as follows:
 - 1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 - 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 1 General Requirements: Requirements of Sections in Division 1 apply to the Work of each specification section.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
 - 1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 - 2. Abbreviations: Materials and products are identified by abbreviations.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 CONSTRUCTION SCHEDULE

Cunningham Middle School and North Shore Middle School Roof Replacement/Recover

- A. The Owner has a critical need for the Work to begin upon Notice to Proceed January 15, 2026, and shall be Substantially Complete by August 1, 2026.
- B. Failure to complete and close-out project 60 days after Substantial Completion will result in liquidated damages being assessed in the amount of \$1,500.00 per calendar day until close-out occurs

Cunningham Middle School HVAC Upgrades

- A. The Owner has a critical need for the Work to begin upon Notice to Proceed and shall be Substantially Complete by **End of Summer Break 2026**. There will be No Extensions of Time due to weather.
- B. Failure to complete and close-out project 60 days after Substantial Completion will result in liquidated damages being assessed in the amount of \$500 per calendar day until close-out occurs and \$1000 per day after final completion date.

END OF SECTION 01 10 0

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements governing allowances.
 - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include:
 - 1. Lump sum allowances.
 - 2. Unit cost allowances.
 - 3. Quantity allowances.
 - 4. Contingency allowances.
 - 5. Testing and inspecting allowances.

1.3 COORDINATION

- A. Coordinate allowance items with other portions of the Work.

1.4 LUMP SUM, UNIT COST, AND QUANTITY ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include taxes, freight, and delivery to site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.5 CONTINGENCY ALLOWANCES

- A. The use of any contingency allowance amount shall only be as authorized by the Owner. The process to include :
 - 1. The Owner identifies a need to request a proposal from the Contractor for a change in the work.
 - 2. The Architect will issue a Change Proposal Request to the Contractor for the change.
 - 3. The Contractor shall submit a proposal for consideration.
 - 4. The Architect and Consultants will review the change proposal and provide a recommendation to the Owner.

5. The Owner shall approve the Change Proposal and authorize the expenditure of the allowance, allowing the Contractor to add the approval proposal amount to the schedule of values.
- B. Contractor's related costs for products and equipment ordered by Owner under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include Contractor's related costs and reasonable overhead and profit margins.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to Owner by Change Order.

1.6 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to Owner by Change Order.

1.7 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 3. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit cost allowances.
 4. Owner reserves the right to establish the quantity of Work in place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.
 2. No change to Contractor's indirect expense is permitted for selection of higher or lower priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related Work.

3.3 SCHEDULE OF ALLOWANCES

- A. Owner's Contingency Allowances for Cunningham Middle School
& North Shore Middle School Roof Replacement/Recover: \$100,000.00
 - 1. Contractor shall include the amount indicated below in his Base Proposal as a contingency to cover the cost of hidden, concealed or otherwise unforeseen conditions which develop during completion of the work. Contractors shall be allowed to recover all costs associated with the completion of work under this contingency; however, no overhead or profit will be allowed.
- B. Owner's Contingency Allowance for Cunningham Middle
School HVAC Upgrades: \$300,000.00
 - 1. Offerors shall include the allowance amount indicated in their Base Proposals as a contingency allowance to cover costs attributable to hidden, concealed or otherwise unforeseen conditions which become apparent during operations under this Contract. The Contractor shall be allowed to recover all direct costs associated with the completion of work authorized under this allowance; however, no Contractor's overhead or profit will be allowed.

END OF SECTION 01 21 00

SECTION 01 22 00 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for unit prices.

1.3 DEFINITIONS

- A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: Refer to the individual Specification Sections for Work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this Work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

Cunningham Middle School & North Shore Middle School Roof Replacement/Recover

- A. For the installation of one 6-inch Roof Drain to include complete assembly and labor.
- B. For the installation of one 8-inch Roof Drain to include complete assembly and labor.
- C. Per linear foot of 6-inch drain line. Cast Iron _____ I.f. PVC _____ I.f.
- D. Per linear foot of 8inch drain line. Cast Iron _____ I.f.PVC _____ I.f.
- E. Per linear foot to install through wall flashing at brick wall.

F. Installation of 4"x6" Downspout:_____l.f.

G. Installation Of 6"x6" Box gutter : _____l.f

Cunningham Middle School HVAC Upgrades

A. Unit Price 1: TBD

END OF SECTION 01 22 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes: Administrative and procedural requirements for alternates.

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain Work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described are part of the Work when enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent Work as necessary to completely integrate Work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Notification: Forty-eight (48) hours following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
- C. Execute accepted alternates under the same conditions as other Work of the Contract.
- D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

Cunningham Middle School & North Shore Middle School Roof Replacement/Recover

- 1. Not used

Cunningham Middle School HVAC Upgrades

A. **Alternate Number 1a:** 23 09 23 – Direct Digital Controls – **Unify Energy Solutions**

1. This Alternate shall establish the amount to adjust the Base Proposal for the cost of furnishing and installing Direct Digital Controls manufactured by **Reliable Controls – Installed by Unify Energy Solutions**. This alternate shall include the pricing for all materials and labor for proper completion. Refer to specs and drawings for additional information.

B. **Alternate Number 1b:** 23 09 23 – Direct Digital Controls – **Automated Logic Corporation**

1. This Alternate shall establish the amount to adjust the Base Proposal for the cost of furnishing and installing Direct Digital Controls manufactured by **Automated Logic Corporation – Installed by Automated Logic Corporation (Houston Office)**. This alternate shall include the pricing for all materials and labor for proper completion. Refer to specs and drawings for additional information.

C. **Alternate Number 1c:** 23 09 23 – Direct Digital Controls – **Trane Tracer**

1. This Alternate shall establish the amount to adjust the Base Proposal for the cost of furnishing and installing Direct Digital Controls manufactured by **Trane Tracer – Installed by Hunton Trane**. This alternate shall include the pricing for all materials and labor for proper completion. Refer to specs and drawings for additional information.

D. **Alternate Number 2a:** 23 73 13 – Modular Indoor Central-Station Air-Handling Units manufactured by **Trane** and 23 63 13 - Air-Cooled Refrigerant Condensers manufactured by **Mitsubishi**

1. This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to furnish Modular Indoor Central-Station Air-Handling Units manufactured by **Trane** and Air-Cooled Refrigerant Condensers manufactured by **Mitsubishi** as shown and scheduled on the drawings and as specified; there are no air handling units and condensing units included in the base bid. All extended warranties etc. shall be included in the alternate equipment price.

E. **Alternate Number 2b:** 23 73 13 - Modular Indoor Central-Station Air-Handling Units manufactured by **Temtrol** and 23 63 13 - Air-Cooled Refrigerant Condensers manufactured by **LG**

1. This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to furnish Modular Indoor Central-Station Air-Handling Units manufactured by **Temtrol** and Air-Cooled Refrigerant Condensers manufactured by **LG** as shown and scheduled on the drawings and as specified; there are no air handling units and condensing units included in the base bid. All extended warranties etc. shall be included in the alternate equipment price.

F. **Alternate Number 3a:** 23 81 26 – Ductless Mini-Split-System Air-Conditioners – **Mitsubishi**

1. This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to furnish Ductless Mini-Split-System Air-Conditioners, manufactured by **Mitsubishi** as shown and scheduled on the drawings and as specified; there are no Ductless Mini-Split-System Air-Conditioners included in the base bid.

G. **Alternate Number 3b:** 23 81 26 – Ductless Mini-Split-System Air-Conditioners – **LG**

1. This Alternate shall establish the amount to be added to the Base Proposal for the Contractor to furnish Ductless Mini-Split-System Air-Conditioners, manufactured by **LG** as shown and scheduled on the drawings and as specified; there are no Ductless Mini-Split-System Air-Conditioners included in the base bid.

END OF SECTION 01 23 00

SECTION 01 25 13 - PRODUCT SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Specified product compliance, and product quality assurance.
- B. Specific administrative and procedural requirements for handling requests for substitutions made prior to award of Contract.
- C. Requirements for product delivery, storage and handling.

1.3 RELATED REQUIREMENTS

- A. Instructions to Offerors: Product options and procedures for submittal of requests for substitutions during the Proposal period.

1.4 DESCRIPTION OF REQUIREMENTS

- A. Definitions: Definitions used in this Section are not intended to negate the meaning of other terms used in the Contract Documents, including such terms as “specialties”, “systems”, “structure”, “finishes”, “accessories”, “furnishings”, “special construction”, and similar terms. Such terms are self-explanatory and have recognized meanings in the construction industry.
 - 1. Products: Shall mean items purchased for incorporation in the Work, regardless of whether they were specifically purchased for the project or taken from the Contractor’s previously purchased stock. The term “product” as used herein includes the terms “material”, “equipment”, “system”, and other terms of similar intent.
 - a. Named Products: Are those identified by the use of the manufacturer’s name for a product, including such items as a make or model designation, as recorded in published product literature, of the latest issue as of the date of the Contract Documents.
 - b. Specified Products: same as Named Products.
 - 2. Materials: Shall mean products that must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed to form units of work.
 - 3. Equipment: Is defined as a product with operational parts, regardless of whether motorized or manually operated, and in particular, a product that requires service connections such as wiring or piping.

1.5 PRODUCT QUALITY ASSURANCE

- A. Source Limitations: To the fullest extent possible, provide products of the same generic kind, from a single source, for each unit of work.
 - 1. When it is discovered that specific products are available only from sources that do not or cannot produce an adequate quantity to complete project requirements in a timely manner, consult with the Architect/Engineer for a determination of what product quantities are most important before proceeding. The Architect/Engineer will designate those qualities, such as visual, structural, durability, or compatibility, that are most important. When the Architect/Engineer’s determination has been made, select products from those

sources that produce products that possess the most important qualities, to the fullest extent possible.

- B. Compatibility of Options: Compatibility of products is a basic requirement of product selection. When the Contractor is given the option of selecting between two (2) or more products for use on the project, the product selected must be compatible with other products previously selected, even if the products previously selected were also Contractor options. The complete compatibility between the various choices available to the Contractor is not assured by the various requirements of the Contract Documents but must be provided by the Contractor.
- C. Or Equal:
 - 1. Where the phrase "or equal", "or equivalent", "or Architects approved equal", or similar phrasing, occurs in the Proposal Documents, do not assume that materials, equipment, or methods of construction will be approved by the Architect unless the item has been specifically approved for this Work by the Architect.
 - 2. The decision of the Architect shall be final.
- D. Where a proposed substitution involves the work of more than one (1) contractor, each contractor involved shall cooperate and coordinate the work with each other contractor involved, so as to provide uniformity and consistency and to assure the compatibility of products.
- E. Foreign Product Limitations: "Foreign products" as distinguished from "domestic products" are defined as products that are either manufactured substantially (50 percent or more of value) outside of the United States and its possessions, or produced or supplied by entities known to be substantially owned (more than 50 percent) by persons who are not citizens of nor living within the United States and its possessions.
 - 1. Except under one (1) of the following conditions, select and provide domestic, not foreign, products for inclusion in the Work.
 - a. There is no domestic product available that complies with the requirements of the Contract Documents.
 - b. Available domestic products that comply with the requirements of the Contract Documents are available only at prices or other procurement terms that are substantially higher (25 percent or more) than for available foreign products that comply with the requirements of the Contract Documents.
 - c. At the discretion of the Architect or Owner.
 - 2. Final determination and acceptance will be the responsibility of the Architect.
- F. Standards: Refer to Section 01 41 00, Regulatory Requirements for the applicability of industry standards to the products specified for the Project, and for the acronyms used in the text of the Specification Sections.

1.6 SUBSTITUTIONS OF PRODUCTS

- A. The products described in the Proposal Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution. The materials and equipment named in, and the procedures covered by these specifications have been selected as a standard because of quality, particular suitability or record of satisfactory performance. It is not intended to preclude the use of equal or better materials or equipment provided that same meets the requirements of the particular project and is approved in an Addendum as a substitution prior to the submission of proposals.
- B. No substitution will be considered prior to receipt of proposals unless written request for approval has been received by the Architect at least seven (7) days prior to the date for receipt of proposals. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including drawings, cuts,

performance and test data and any other information necessary for an evaluation. The Architect's decision of approval or disapproval of a proposed substitution shall be final.

- C. If the Architect approves any proposed substitution prior to receipt of proposals, such approval will be set forth in an Addendum. Offerors shall not rely upon approvals made in any other manner.
- D. The Architect and Owner reserve the right to disapprove the use of any manufacturer who in their judgment is unsuitable for use on the Project and that decision will be final
- E. The following are not considered as substitutions:
 - 1. Revisions to the Contract Documents, when requested by the Owner, Architect, or any of their consultants are considered as "changes" not substitutions.
 - 2. Specified Contractor options on products and construction methods included in Contract Documents are choices made available to the Contractor and are not subject to the requirements specified in this Section for substitutions.
 - 3. Except as otherwise provided in the Contract Documents, the Contractor's determination of and compliance with governing authorities do not constitute "substitutions" and do not constitute a basis for change orders.
- F. The following may be considered as a reason for a request for substitution:
 - 1. The request is directly related to an "or approved equal" clause or similar language in the Contract Documents.
 - 2. The specified product or method of construction cannot be provided within the Contract Time in accordance with paragraph below concerning availability of specified items.
 - 3. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 - 4. A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other consideration of merit, after deducting offsetting responsibilities the Owner may be required to bear. These additional responsibilities may include such considerations as additional compensation to the Architect/Engineer for redesign and evaluation services, the increased cost of other work by the Owner or separate contractors, and similar considerations.
 - 5. The specified product or method of construction cannot be provided in a manner that is compatible with other materials, and where the Contractor certifies that the substitution will overcome the incompatibility.
 - 6. The specified product or method of construction cannot be coordinated with other materials, and where the Contractor certifies that the proposed substitution can be coordinated.
 - 7. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where the Contractor certifies that the proposed substitution provides the required warranty.
- G. Availability of specified items:
 - 1. Verify prior to submittal of Proposal that all specified items will be available in time for installation during orderly and timely progress of the work.
 - 2. In the event specified items will not be so available, notify the Architect prior to receipt of Proposals. Submit Request for Substitutions in accordance with this section.
 - 3. The request will not be considered if the product or method cannot be provided as a result of the Contractor's failure to pursue the work promptly or coordinate activities properly.
 - 4. Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.

- H. A request constitutes a representation that Offeror:
1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 2. Will provide same warranty for Substitution as for specified product, except when inability to provide specified Warranty is reason for request for substitution as described above.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 5. Will reimburse the Owner and pay for all costs, including Architect/Engineer's redesign and evaluation costs resulting from the use of the proposed substitution, or for review or redesign services associated with re-approval by authorities having jurisdiction.
- I. **No substitutions will be considered after the Award of Contract.**

1.7 SUBSTITUTION REQUEST SUBMITTAL

- A. Requests for Substitutions: Submit three (3) copies of each request for substitution. In each request identify the product or fabrication or installation method to be replaced by the substitution; include related Specifications Section and Drawing numbers, and complete documentation showing compliance with the requirements for substitutions. Include, as appropriate, with each request, the following information:
1. Product data, drawings and descriptions of products, fabrication and installation procedures.
 2. Samples, where applicable or requested.
 3. A detailed comparison of the significant qualities of the proposed substitution with those of the work originally specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect, where applicable.
 4. Coordination information, including a list of changes or modifications needed by other parts of the work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
 5. A statement indicating the effect the substitution will have on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
 6. Cost information, including a proposal of the net change, if any in the Contract Sum.
 7. Certification by the Contractor to the effect that, in the Contractor's opinion, after thorough evaluation, the proposed substitution will result in work that in every significant respect is equal-to or better than the work required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
 8. A statement indicating the Contractor will reimburse the Owner and pay for all costs, including Architect/Engineer's re-design and evaluation costs resulting from the use of the proposed substitution.
- B. Work-Related Submittals: The Contractor's submittal of, and the Architect/Engineer's acceptance of, Shop Drawings, Product Data, or Samples which are related to work not complying with the Contract Documents, does not constitute an acceptance or valid request for a substitution, nor approval thereof.

1.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. General: Deliver, store, and handle products in accordance with manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft. Control to prevent overcrowding of construction spaces or overloading of structure. In particular, coordinate delivery and installation to ensure minimum holding or storage

times for items known or recognized to be flammable, hazardous, easily damaged, or sensitive to deterioration, theft and other sources of loss.

1. Deliver products to the site in the manufacturer's sealed containers or other packaging system, complete with labels intact, and instructions for handling, storage, unpacking, installing, cleaning and protecting.
2. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation or potential degradation of product.
3. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
4. Store products at the site or in a bonded and insured off-site storage facility or warehouse in a manner that will facilitate inspection and measurement of quantity or counting of units. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
5. Store heavy materials away from the project structure or in a manner that will not endanger the supporting construction.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT COMPLIANCE

- A. General: Requirements for individual products are indicated in the Contract Documents; compliance with these requirements is in itself a contract requirement. These requirements may be specified in anyone (1) of several different specifying methods, or in any combination of these methods. These methods include the following:
 1. Proprietary.
 2. Descriptive.
 3. Performance.
 4. Compliance with Reference Standards.
- B. Compliance with codes, compliance with graphic details, allowances, and similar provisions of the Contract Documents also have a bearing on the selection process
- C. Procedures for Selecting Products: The Contractor's options in selecting products are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects. Required procedures include, but are not limited to the following for the various indicated methods of specifying:
 1. Proprietary and Semi-Proprietary Specification Requirements:
 - a. Single Product Name: Where only a single product or manufacturer is named, provide the product indicated, unless the specification indicates the possible consideration of other products. Advise the Architect/Engineer before proceeding, when it is discovered that the named product is not a reasonable or feasible solution.
 - b. Two (2) or More Product Names: Where two (2) or more products or manufacturers are named, provide one (1) of the products named, at the Contractor's option. Exclude products that do not comply with specification requirements. Do not provide or offer to provide an unnamed product, unless the specification indicates the possible consideration of other products. Advise the Architect/Engineer before proceeding where none of the named products comply with specification requirements or are not feasible for use. Where products or manufacturers are specified by name, accompanied by the term "or approved equal" or similar language, comply with this Section regarding "substitutions" to obtain approval from the Architect/Engineer for the use of an unnamed product.
 2. Non-Proprietary Specification Requirements: Where the specifications name products or manufacturers that are available and may be incorporated in the Work, but do not restrict

- the Contractor to the use of these products only, the Contractor may, at his option, use any available product that complies with the Contract requirements.
3. Descriptive Specification Requirements: Where the specifications describe a product or assembly generically, in detail, listing the exact characteristics required, but without use of a brand name, provide products or assemblies that provide the characteristics indicated and otherwise comply with Contract requirements.
 4. Performance Specification Requirements: Where the specifications require compliance with indicated performance requirements, provide products that comply with the specific performance requirements indicated, and that are recommended by the manufacturer for the application indicated. The manufacturer's recommendations may be contained in published product literature, or by the manufacturer's individual certification of performance. General overall performance of a product is implied where the product is specified for specific performances.
 5. Compliance with Standards, Codes, and Regulations: Where the specifications require only compliance with an imposed standard, code or regulation, the Contractor has the option of selecting a product that complies with specification requirements, including standards, codes, and regulations.
 6. Visual Matching: Where matching an established sample is required, the final judgement of whether a product proposed by the Contractor matches the sample satisfactorily will be determined by the Architect. Where there is no product available within the specified product category that matches the sample satisfactorily and also complies with other specified requirements, comply with the provisions of this Section regarding "substitutions" and other Contract Documents for "change orders" for the selection of a matching product in another product category, or for non-compliance with specified requirements.
 7. Visual Selection: Except as otherwise indicated, where specified product requirements include the phrase "...as selected from the manufacturer's standard colors, patterns, textures..." or similar phrases, the Contractor has the option of selecting the product and manufacturer, provided the selection complies with other specified requirements. The Architect is subsequently responsible for selecting the color, pattern and texture from the product line selected by the Contractor.
 8. Allowances: Refer to individual sections of the specifications and Section 01 21 00, Allowances for an indication of product selections that are controlled by established allowances, and for the procedures required for processing such selections.
- D. Producer's Statement of Applicability: Where individual specification sections indicate products that require a "Statement of Applicability" from the manufacturer or other producer, submit a written-certified statement from the producer stating that the producer has reviewed the proposed application of the product on the project. This statement shall state that the producer agrees with or does not object to the Architect/Engineer's specifications and the Contractor's selection of the product on the project is suitable and proper.

2.2 SUBSTITUTIONS

- A. Condition: The Contractor's request for substitution will be received and considered when extensive revisions to Contract Documents are not required, when the proposed changes are in keeping with the general intent of the Contract Documents, when the request is timely, fully documented and properly submitted, and when one (1) or more of the above conditions are satisfied, all as judged and determined by the Architect/Engineer; otherwise the requests will be returned without action except to record non-compliance with these requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF PRODUCTS

- A. General: Except as otherwise indicated in individual sections of these specifications, comply with the manufacturer's instructions and recommendations for installation of the products in the applications indicated.
- B. Anchor each product securely in place, accurately located and aligned with other work.
- C. Clean exposed surfaces and protect surfaces as necessary to ensure freedom from damage and deterioration at time of acceptance.
- D. Products and assemblies shall be installed complete, in-place, watertight and structurally sound.

3.2 INSTALLATION OF APPROVED SUBSTITUTIONS

- A. Coordinate all approved substitutions with adjacent work.
- B. Comply with the manufacturer's and/or supplier's instructions and recommendations for installation of the products in the applications indicated.
- C. Provide all items required by manufacturer and/or supplier regarding installation, i.e. supplemental supports, anchors, fasteners, painting, etc. whether or not indicated or specified.

END OF SECTION 01 25 13

01 25 13.01 - REQUEST FOR SUBSTITUTION

Contract Award Date: _____

To: _____

Substitution Requested By: _____

Project Name and Number: _____

We submit for consideration the following product in lieu of the specified item for the above project:

Drawing No.	Specification Section	Paragraph	Specified Item

_____	_____	_____	_____

Proposed Substitution: _____

Request is made during ____ bidding ____ construction period.

Submit in accordance with Section 01 33 00.

1. Technical data, cost, and time information relating to changes to Construction Documents required by proposed substitution.
2. Detailed comparison of proposed substitution and specified product including but not limited to warranty, significant variations, qualifications of manufacturers, and maintenance.
3. Complete technical data, detailed shop drawings, samples, installation procedures, warranty, and substantiating data marked to indicate equivalent quality and performance to that specified. Manufacturer sell sheets are not acceptable submittals.

Cause for Request: _____

Cost saving realized by Owner _____

Does substitution affect adjacent Work, Construction Documents, cost, schedule, quality, and related submittals?

Yes ____ No ____ On separate sheet, explain affects to the Work, documents, schedule, and submittals.

The Contractor is responsible for associated costs and additional time of the proposed substitution including costs incurred by the Architect for evaluation of substitution and changes to the documents. Describe costs for changes to design, including engineering and detailing costs caused by the requested substitution.

Warranty: Is the warranty for the requested substitution the same? Yes ____ No ____

If different, Explain Differences:

Contractor Certification:

In making a request for substitution, the Contractor certifies that:

1. The proposed substitution has been thoroughly researched and evaluated and determined as equivalent or superior to specified product or material, will fit into space provided, and is compatible with adjacent materials.
2. It will provide the same or better warranty for the proposed substitution at no additional cost to the Owner.
3. Cost data is complete and includes related costs under the Contract. Claims for additional costs related to the proposed substitution that may subsequently become apparent are waived.
4. It will assume the responsibility for delays and costs caused by the proposed substitution, if approved, are accepted by the Contractor unless delays are and costs are specifically mentioned and approved in writing by the Owner and the Architect.
5. It will assume the liability for the performance of the substitution and its performance.
6. The installation of the proposed substitution is coordinated with the Work and with changes required for the Work.
7. It will reimburse the Owner and Architect for evaluation and redesign services associated with the substitution request and, when required, by approval by governing authorities.

____ Has the substituted manufacturer/product been installed on previous PBK projects?

If so, list project(s): (List projects within the last two years)

1. _____
District: _____
Contact: _____
2. _____
District: _____
Contact: _____

Submitted by:

Signature of Contractor Title

Firm Telephone Date

Signature shall be by the individual authorized to legally bind the Contractor's to the above terms. Failure to provide legally binding signature will result in retraction of approval.

FOR USE BY ARCHITECT:

____ Accepted ____ Accepted as Noted
____ Not Accepted ____ Received Too Late

By: _____

Date: _____

Remarks: _____

FOR USE BY OWNER:

____ Accepted ____ Not Accepted

By: _____

By: _____

Remarks: _____

END OF SECTION 01 25 13.01

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for handling and processing Contract modifications.
- B. Related Work:
 - 1. Section 01 25 13 – Product Substitution Procedures.

1.3 MINOR CHANGES IN THE WORK

- A. Architect will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on AIA Document G710 *Architect's Supplemental Instructions*.

1.4 PROPOSAL REQUESTS

- A. Owner Initiated Proposal Requests: Architect will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
 - 1. Work Change Proposal Requests issued by Architect are not instructions either to stop Work in progress or to execute the proposed change.
 - 2. After receipt of Proposal Request, submit quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
 - a. Include list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Architect.
 - 1. Include statement outlining reasons for the change and the effect of the change on the Work. Provide complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
 - 2. Include list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - 4. Include costs of labor and supervision directly attributable to the change.
 - 5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times,

- and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 01 25 00 if the proposed change requires substitution of one product or system for product or system specified.
 7. Proposal Request Form: Use AIA Document G709.
- C. Contractor has ten (10) business days to submit pricing or submit resubmittal pricing to the Architect after issuance of a CPR or Change Proposal.
- D. Regardless of initiated change request pricing, a fully developed and completed change pricing to be submitted.

1.5 ADMINISTRATIVE CHANGE ORDERS

- A. Allowance Adjustment: When an allowance is specified, refer to Section 01 21 00 for administrative procedures for preparation of Change Order Proposal for adjusting the Contract Sum to reflect actual costs of allowances.
1. Allowance Adjustment: To adjust allowance amounts, base each Change Proposal Request (CPR) on the difference between purchase amount and the allowance, multiplied by final measurement of Work in place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.
 - a. Include installation costs in purchase amount only where indicated as part of the allowance.
 - b. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.
 - c. Submit substantiation of a change in scope of Work, if any, claimed in Change Orders related to unit cost allowances.
 - d. Owner reserves the right to establish the quantity of Work in place by independent quantity survey, measure, or count.
 2. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or Contractor's handling, labor, installation, overhead, and profit. Submit claims within 7 days of receipt of the Change Order authorizing work to proceed. Owner will reject claims submitted later than 7 days after authorization.

1.6 CHANGE ORDER PROCEDURES

- A. On Owner's approval of a Work Changes Proposal Request, Architect will execute a Change Order also requiring signatures of Owner and Contractor on AIA Document G701.

1.7 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: Architect may issue a Construction Change Directive on AIA Document G714. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. Construction Change Directive contains a complete description of change in the Work and designates the method to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of Work required by the Construction Change Directive. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

BEAM Professionals
Project No. 250373
Issue For Proposal

Cunningham Middle School and North Shore Middle School
Galena Park Independent School District
December 05, 2025

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 26 00

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.3 DEFINITIONS

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.
- B. Pencil Copy: A preliminary review copy of the application for payment for review by Architect and Owner prior to submission of final copy.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.
 - 1. Coordinate line items in the schedule of values with administrative forms and schedules, including the following:
 - a. Application for Payment forms with continuation sheets.
 - b. Updated Submittal schedule.
 - c. Items required to be indicated as separate activities in updated Contractor's construction schedule.
 - 2. Submit the schedule of values to Architect at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment. Contractor's standard form or electronic media printout will be considered but must be approved by the Owner.
- B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.
 - 1. Identification: Include the following Project identification on the schedule of values:
 - a. Project name and location.
 - b. Name of Architect.
 - c. Architect's project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 - 2. Arrange schedule of values consistent with format of AIA Document G703.
 - 3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of supplier.
 - f. Change Orders (numbers) that affect value.

- g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
 - 1) Labor.
 - 2) Materials.
 - 3) Equipment rentals.
 - 4) General Conditions.
 - a. Supervisor.
 - b. Submittals.
 - c. Close-out.
 - d. Field Engineering.
 - e. Daily Clean-up.
 - f. Final Clean-up.
- 4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
- 5. Provide separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
 - a. Differentiate between items stored on site and items stored off site. Include evidence of insurance.
- 6. Allowances: Provide a separate line item in the schedule of values for each allowance. Show line item value of unit cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
- 7. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - a. Temporary facilities and other major cost items that are not direct cost of actual Work in place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.
- 8. Schedule Updating: Update and resubmit the schedule of values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

1.5 APPLICATIONS FOR PAYMENT

- A. Submit preliminary (pencil) copy of proposed values to Architect or Architects field representative and Owner for review by 20th date of the month. Allow 48 hours for comments.
- B. Once preliminary (pencil) approved, submit electronic copy of notarized originals of each application on AIA Form G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet for G702 or other similar form approved by the Owner.
- C. Content and Format: Utilize Schedule of Values for listing items in Application for Payment.
- D. Submit updated construction or recovery schedule with each Application for Payment.
- E. Payment Period: Submit at intervals stipulated in the Agreement in accordance with Document 00 73 00, Supplementary Conditions of the Contract.
- F. Only materials stored on the project site shall be paid for unless the materials are stored in a bonded warehouse.
- G. Substantiating Data: When Architect/Engineer requires substantiating information, submit data justifying dollar amounts in question. Items which may be requested by the Architect or Owner to substantiate costs include, but are not limited to the following:
 - 1. Current Record Documents as specified in Section 01 77 00, Closeout Procedures

PAYMENT PROCEDURES

- maintained.
- 2. Labor time sheets, purchase orders, or similar documentation.
- 3. Affidavits attesting to off-site stored products.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 29 00

SECTION 01 29 73 - SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. Work Included: Provide a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the work, as specified herein and in other provisions of the Contract Documents.
- B. Coordinate requirements of this Section with the requirements of the General and Supplementary Conditions of the Contract concerning Schedule of Values.

1.3 QUALITY ASSURANCE

- A. Use required means to assure arithmetical accuracy of the sums described.
- B. When so required by the Owner, provide copies of the subcontracts or other data acceptable to the Owner, substantiating the sums described.

1.4 SUBMITTALS

- A. Prior to the first Application for Payment, submit a proposed schedule of values to the Owner, as outlined below:
 - 1. Meet with the Owner and determine additional data, if any, required to be submitted.
 - 2. Secure the Owner's approval of the schedule of values prior to submitting first Application for Payment.

1.5 SCHEDULE OF VALUES

- A. The Schedule of Values shall be broken down into item costs for each specification section as a minimum. After review by the Owner, the Schedule of Values shall be broken down into further items as required. (See following list). In addition, total each Specification Division separately.
- B. Schedule of Values - Items in addition to Specification Sections.
 - 1. Mobilization
 - 2. Clean Up
 - 3. Building Permit
 - 4. Bonds, Insurance
 - 5. Misc. Mechanical Accessories
 - 6. Demolition
 - 7. Roof Removal
 - 8. Insulation
 - 9. Base Ply
 - 10. Base Flashing
 - 11. Finish Ply
 - 12. Sheetmetal
 - 13. Soft Joints
 - 14. Allowances (listed separately)

- 15. Record drawings and close-out documents
- 16. Submittals
- 17. Roof warranty

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 SCHEDULE OF VALUES

Not used.

END OF SECTION 01 29 73

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Div. 1 - General Reqs. Site Work General Conditions Supervision Mobilization Bonds & Insurance Permits Contractor's Fee Close-Out Documents								
	Div. 1 - Total								
	Div. 2 - Existing Conditions Demolition (As applicable) Erosion Control Div. 2 - Total								
	Div. 3 - Concrete Drill Piers Caps & Beams Slab on Grade Cooling Tower Basin Misc Bldg Conc Floor Sealer Rebar Matl Rebar Labor Lt.Wt.Insul Fill - Materials Lt.Wt.Insul Fill - Labor Submittals/Close-Out Documents Supervision Clean-up								
	Div. 3 - Total Div 4 - Masonry Brickwork - Labor Brickwork - Matls Concrete Masonry - Labor Concrete Masonry - Materials Str. Glazed Tile-Labor Str. Glazed Tile-Materials Submittals/Close-Out Documents Supervision Clean-up								
	Div. 4 - Total								
	Div 5 - Metals Structural Steel - Labor Structural Steel - Materials Alternating Stairs Misc. Steel - Materials Steel Joists - Materials Lt. Gauge Steel Framing-Labor Lt. Gauge Steel Framing-Matls Metal Decking - Labor Expansion Joint Covers Metal Decking - Matls								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Detailing Submittals/Close-Out Documents Supervision Clean-up								
	Div. 5 - Total								
	Div. 6 - Wood & Plastics Rough Carpentry - Labor Rough Carpentry - Materials Millwork - Labor Millwork - Materials Submittals/Close-Out Documents								
	Div. 6 - Total								
	Div. 7 - Thermal and Moisture Protection Waterpfng / Dampprfng-Matls Waterpfng / Dampprfng-Labor Building Insulation - Labor Building Insulation - Materials Fireproofing - Labor Fireproofing - Materials Metal Roof - Labor Metal Roof - Materials Metal Roof Guarantee Built-up Roofing-Labor Built-up Roofing-Materials Built-up Roofing Guarantee Roof Accessories Building Sheet Metal - Labor Building Sheet Metal - Matls Bldg. Sheet Metal Guarantee Roof Curbs Roof Hatches Sealants Submittals/Close-Out Documents Supervision Clean-up								
	Div. 7 - Total								
	Div. 8 - Doors and Frames Finish Carpentry/Door - Labor Finish Hardware - Matls Thresholds & Seals - Matls+B66 Hollow Metal Doors & Frames - Matls Plastic Faced Doors-Matls Overhead Doors & Grilles-Labor Overhead Doors & Grilles - Matls Alum. Entrances & Store-fronts - Labor Alum. Entrances & Store-								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	fronts - Matls Alum. Windows - Labor Alum Windows - Matls Glass & Glazing-Labor Glass & Glazing-Matls Submittals/Close-Out Documents Supervision Clean-up								
	Div. 8 - Total								
	Div. 9 - Finishes Lath & Plaster-Labor Lath & Plaster-Matls Gypsum Wallboard Systems - Labor Gypsum Wallboard Systems - Matls Ceramic Tile - Labor Ceramic Tile - Matls Quarry Tile - Labor Quarry Tile - Matls Terrazzo-Labor Terrazzo-Matls Acoustic Clg. - Labor Acoustic Clg. - Matls Acoustic Wall Panels Resilient Flooring - Labor Resilient Flooring - Matls Carpet - Labor Carpet - Matls Athletic Flooring - Materials Athletic Flooring - Labor Floor Sealer Painting - Labor Painting - Mtls Submittals/Close-Out Documents Supervision Clean-up								
	Div. 9 - Total								
	Div. 10 - Specialties Visual Display Boards & Tackboards - Materials Visual Display Boards & Tackboards - Labor Toilet Partitions - Labor Toilet Partitions - Matls Louvers Aluminum Flag Pole Graphics Lockers Cubicle Curtains & Track Fire Extinguisher Cabinets Demountable Partitions-Labor								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Demountable Partitions-Matls Shelving Toilet Room Accessories-Matls Toilet Room Accessories-Lbr Submittals/Close-Out Documents Supervision Clean-up								
	Div. 10 - Total								
	Div. 11 - Equipment Stage Curtains Misc. Appliances Food Service Eqpt-Labor Food Service Eqpt-Matls Submittals/Close-Out Documents Supervision Clean-up								
	Div. 11 - Total								
	Div. 12 - Furnishings Horizontal Blinds Projection Screens Casework - Labor Casework - Matls Science Casework - Labor Science Casework - Matls Submittals/Close-Out Documents Supervision Clean-up								
	Div. 12 - Total								
	Div. 13 - Specialties Stage Curtains and Draperies Music Instrument Storage Bleachers Press Box Pre-eng. Metal Bldg. Stadium Seating Submittals/Close-Out Documents Supervision Clean-up								
	Div. 13 - Total								
	Div. 14 - Conveying Systems Platform Lifts Elevators Submittals/Close-Out Documents Supervision Clean-up								
	Div. 14 - Total								
	Div. 21, 22 - Plumbing Shop Drawings As-Builts/Close-Out/ O&M Manuals Sanitary Underground -								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Labor Sanitary Underground - Matls Storm Underground - Labor Storm Underground - Matls Domestic Water - Labor Domestic Water - Matls Plumbing Insulation - Matls Plumbing Insulation - Labor Gas Piping - Matls Gas Piping - Labor Grease Trap Plumbing Fixtures - Matls Plumbing Fixtures - Labor Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up								
	Div. 21, 22 Plumbing - Total								
	Div. 23 - Mechanical Shop Drawings As-Builts/Close-Out/ O&M Manuals Chillers - Matls Chillers - Labor Cooling Towers - Matls Cooling Towers - Labor Boilers - Matls Boilers - Labor AHU's - Matls AHU's - Labor Fans - Matls Fans - Labor Grilles - Matls Grilles - Labor Ductwork - Matls Ductwork - Labor Pumps - Mtls Pumps - Labor Water Treatment - Labor Water Treatment - Matls Isolation - Labor Isolation - Matls Pipe Flex - Matls Pipe Flex - Labor Connections Sheet Metal - Matls Sheet Metal - Labor Duct Insulation - Matls Duct Insulation - Labor								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Pipe Insulation - Matls Pipe Insulation - Labor VAV Boxes - Materials VAV Boxes - Labor Refrigerant Monitor - Matls Refrigerant Monitor - Labor Unit Heaters - Materials Unit Heaters - Labor Startup Controls - Matls Control - Labor Engineer / Submittals Modules / End Devices Low Voltage Wiring Startup Close-Out Documents Fire Sprinkler Engineer / Submittals Piping - Materials Piping - Labor Equipment - Materials Equipment - Labor Trimout - Materials Trimout - Labor Pipe, Valves, Fittings - Labor Pipe, Valves, Fittings - Matls Misc. - Matls Insulation - Matls Insulation - Labor Sanitary Above Slab-Labor Sanitary Above Slab-Matls Storm Above Slab - Labor Storm Above Slab - Matls Gas - Labor Gas - Matls Fixtures - Labor Fixtures - Matls Permits Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up								
	Div. 23 Mechanical - Total								
	Div. 26 - Electrical								
	Mobilization+B220 Shop Drawings As-Builts/Close-Out/ O&M Manuals Underground Conduit - Labor Conduit - Matl Wire - Labor								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Wire - Matls Feeder Wire - Labor Feeder Wire - Matls Switches/Recpt. Switchgear - Labor Switchgear - Matls Temporary - Materials Temporary - Labor Gas Generator - Materials Gas Generator - Labor Fixtures - Labor Fixtures - Matls Communications - Labor Communications - Matls Fire Alarm - Labor Fire Alarm - Matls Security - Labor Security - Matls Low Voltage Ltng Sys-Matls Low Voltage Ltng Sys-Labor Voice System - Materials Voice System - Labor Video System - Materials Video System - Labor Data System - Materials Data System - Labor Master Clock - Materials Master Clock - Labor+B277 Coordination Drawings Submittals/Close-Out Documents Supervision Clean-up								
	Div. 26 - Total								
	Divs. 31, 32 and 33 - Earthwork, Exterior Improvements and Utilities								
	Site Clearing & Grubbing Building Pad - Materials Building Pad - Labor Paving Subgrade Signage / Striping Bike Racks Landscaping - Materials Landscaping - Labor Hydro Mulch - Materials Hydro Mulch - Labor Irrigation - Materials Irrigation - Labor Earthwork Finish Grading Stabilization - Materials Stabilization - Labor Site Drainage - Materials Site Drainage - Labor								

SECTION 01 29 73

SCHEDULE OF VALUES - SAMPLE

Item No.	Description of Work	Scheduled Value	Work Completed		Stored Materials	Total Completed	%	Balance To Finish	Retainage
			Previous App.	This App.					
	Chain Link Fence-Materials Chain Link Fence-Labor Paving - Labor Paving - Materials Sidewalks Submittals/Close-Out Documents Supervision Clean-up								
	Div. 31, 32 and 33 - Total								
	General Conditions Mobilization Temp. Facilities Final Cleaning Record Documents/Close-out/ O&M Manuals Supervision Permits Bonds Insurance Allowances Alternates (list) Change Orders A. PR# B. PR# C. PR#								

END OF SECTION

SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
 - 1. General coordination procedures.
 - 2. Coordination drawings.
 - 3. Pre-install meetings.
- B. Each Contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific Contractor.
- C. Contractor shall make a reasonable attempt to interpret the Contract Documents before asking the Architect for assistance in interpretation. Requests for Information (RFI's) will not be allowed from the Contractor. The Contractor shall arrange the necessary meeting in the field with appropriate Architect's field representative(s) to obtain clarification as needed on items that may need interpretation.

1.3 SUBMITTALS

- A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
 - 1. Name, address, and telephone number of entity performing subcontract or supplying products.
 - 2. Number and title of related Specification Section(s) covered by subcontract.
 - 3. Drawing number and detail references, as appropriate, covered by subcontract.
- B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including office, and cellular telephone numbers and email addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.
 - 1. Post copies of list in project meeting room, in temporary field office, and by each temporary telephone. Keep list current at all times.

1.4 COORDINATION PROCEDURES

- A. Coordination: Coordinate construction operations to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations that depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.

- B. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections, which depend on each other for proper installation, connection, and operation.
 - 1. Schedule construction operations in sequence required to obtain best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
 - 3. Make adequate provisions to accommodate items scheduled for later installation.
- C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include items as required notices, reports, and list of attendees at meetings.
 - 1. Prepare similar memoranda for Owner and separate Contractors if coordination of the Work is required.
- D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Administrative activities include, but are not limited to, the following:
 - 1. Preparation of Contractor's construction schedule.
 - 2. Preparation of the schedule of values.
 - 3. Installation and removal of temporary facilities and controls.
 - 4. Delivery and processing of submittals.
 - 5. Progress meetings.
 - 6. Preinstallation conferences.
 - 7. Project closeout activities.
 - 8. Startup and adjustment of systems.
 - 9. Coordinating inspections and other jurisdictional requirements.
 - 10. Coordinate OFCI equipment.
 - 11. Action items and issue logs.
- E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.
 - 1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. Refer to the Specifications Sections for disposition of salvaged materials that are designated as Owner's property.

1.5 COORDINATION DRAWINGS

- A. Coordination Drawings: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely shown on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.
 - 1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:
 - a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
 - b. Coordinate the addition of trade specific information to the coordination drawings by multiple Contractors in sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
 - c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.

- d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
 - e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
 - f. Indicate required installation sequences.
 - g. Indicate dimensions shown on the Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
- B. Coordination Drawing Organization: Organize coordination drawings:
 1. Roof Plans: Show architectural and structural elements Work. Show locations of visible equipment, added equipment, gas lines, electrical lines and deck replacement.. Supplement plan drawings with section drawings where required to adequately represent the Work.
 2. Structural Penetrations: Indicate penetrations.
 3. Review: Consultant will review coordination drawings to confirm that the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Consultant determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Consultant will so inform Contractor, who shall make changes as directed and resubmit.
 4. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 00.
- C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:
 1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.
 2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format.
 3. Architect will furnish Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.
 - a. Consultants make no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
 - b. Digital Data Software Program: Drawings are available in Revit.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106.

1.6 PROJECT MEETINGS

- A. Schedule and conduct meetings and conferences at Project site unless otherwise indicated.
 1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner and Architect of scheduled meeting dates and times.
 2. Agenda: Architect to prepare the meeting agenda and distribute the agenda to all invited attendees.
 3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within three days of the meeting.
 4. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
 5. Issue logs: Documentation element of software project management and contains a list of ongoing and closed issues of the project.

- B. Kick-off & Preconstruction Conference: Contractor will schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner and Architect.
 - 1. Conduct the conference to review responsibilities and personnel assignments.
 - 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other parties concerned shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that affect progress.
 - 4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.
 - 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- C. Preinstallation Conferences: Conduct a preinstallation trade conference at site before each construction activity that requires coordination with other construction trades.
 - 1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Architect and Engineer of Record of scheduled meeting dates.
 - 2. Agenda: Contractor to review progress of other construction activities and preparations for the activity under consideration.
 - 3. Contractor to record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
 - 4. Reporting: Contractor distributes minutes of the meeting to each party present and to other parties requiring information.
 - 5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.
 - 6. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.
 - 1. Conduct the conference to review requirements and responsibilities related to Substantial Completion.
 - 2. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Discuss items of significance that could affect or delay Project closeout.
 - 4. Minutes: Entity conducting meetings will record and distribute meeting minutes.
 - 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- E. Progress Meetings: Conduct progress meetings at weekly intervals.
 - 1. Coordinate dates of meetings with preparation of payment requests.
 - 2. Attendees: In addition to representatives of Owner and Architect, each Contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
 - 3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind

schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.
 - a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.
 - b. Six (6) week look-ahead schedules.
 5. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.
- F. Coordination Meetings: Conduct coordination meetings at weekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.
1. Attendees: In addition to representatives of Owner and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
 2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.
 - a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
 - b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
 - c. Review present and future needs of each Contractor present.
 3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.
 4. Action Items: An element of work, design, research, or other task to be completed before a specific date or time, such as before a subsequent meeting of involved parties.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Startup construction schedule.
 - 2. Contractor's construction schedule.
 - 3. Construction schedule updating reports.
 - 4. Daily construction reports.
 - 5. Material location reports.
 - 6. Site condition reports.
 - 7. Special reports.

1.3 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the schedule of values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by Architect.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Float: The measure of leeway in starting and completing an activity.
 - 1. Float time is not for the exclusive use or benefit of either Owner or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
 - 3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.
- F. Resource Loading: The allocation of manpower and equipment necessary for completion of an activity as scheduled.
- G. Recovery Schedule: Submittal of a revised critical path method (CPM) schedule and a written plan.
- H. Look-ahead Schedule: Prepare schedule indicating activities scheduled to occur or commence prior to submittal of next schedule update.

- I. Milestones: Measurable and observable and serve as progress markers (flags) but, by definition, are independent of time (have zero durations) therefore no Work or consumption of resources is associated with them.

1.4 SUBMITTALS

- A. Submittal Format: Submit required submittals in the following format:
 - 1. Working electronic copy of schedule file, where indicated.
 - 2. PDF electronic file.
- B. Startup Diagram: Of size necessary to display entire network for entire construction period. Show logic relationship ties for all activities.
- C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
 - 1. Submit a working electronic copy of schedule, labeled to comply with requirements for submittals. Include type of schedule (initial or updated) and date on label.
- D. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known.
 - 3. Total Float Report: List of all activities sorted in ascending order of total float.
 - 4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
- E. Construction Schedule Updating Reports: Submit with Applications for Payment.
- F. Daily Construction Reports: Submit at weekly intervals.
- G. Material Location Reports: Submit at monthly intervals.
- H. Site Condition Reports: Submit at time of discovery of differing conditions.
- I. Special Reports: Submit at time of unusual event.

1.5 QUALITY ASSURANCE

- A. Prescheduling Conference: Conduct conference at site. Review methods and procedures related to the preliminary construction schedule and Contractor's construction schedule, including, but not limited to, the following:
 - 1. Review software limitations and content and format for reports.
 - 2. Verify availability of qualified personnel needed to develop and update schedule.
 - 3. Discuss constraints, including phasing, Work stages, area separations, interim milestones, and partial Owner occupancy.
 - 4. Review delivery dates for Owner furnished products.
 - 5. Review schedule for Work of Owner's separate contracts, if any.
 - 6. Review submittal requirements and procedures.
 - 7. Review time required for review of submittals and resubmittals.
 - 8. Review requirements for tests and inspections by independent testing and inspecting agencies.
 - 9. Review time required for Project closeout and Owner startup procedures.
 - 10. Review and finalize list of construction activities to be included in schedule.
 - 11. Review procedures for updating schedule.

1.6 COORDINATION

- A. Coordinate Contractor's construction schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.
 - 1. Secure time commitments for performing critical elements of the Work from entities involved.
 - 2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Time is of the essence to the Owner. Commence Work immediately upon issuance of the Notice to Proceed. There is a critical need for the Work to be substantially complete within the time frame identified in the Agreement.
- B. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion and date of final completion.
 - 1. Contract completion date shall not be changed by submission of schedule that shows an early completion date, unless specifically authorized by Change Order.
- C. Activities: Treat each separate area or story as a separate numbered activity for each main element of the Work. Comply with the following:
 - 1. Activity Duration: Define activities in terms of number of days anticipated.
 - 2. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
 - 3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 in schedule. Coordinate submittal review times in Contractor's construction schedule with submittal schedule.
 - 4. Startup and Testing Time: Include number of days anticipated for startup and testing.
 - 5. Substantial Completion: Indicate completion of all conditions as in advance of date established for Substantial Completion, and allow time for Architect's administrative procedures necessary for certification of Substantial Completion.
 - 6. Punch List and Final Completion: Include a maximum of 30 days for completion of punch list items and final completion.
 - 7. Inspections required by Authorities Having Jurisdiction (AHJ).
- D. Constraints: Include constraints and Work restrictions indicated in the Contract Documents and show how the sequence of the Work is affected.
 - 1. Work Restrictions: Show the effect of the following items on the schedule:
 - a. Coordination with existing construction.
 - b. Limitations of continued occupancies.
 - c. Uninterruptible services.
 - d. Partial occupancy before Substantial Completion.
 - e. Use of premises restrictions.
 - f. Provisions for future construction.
 - g. Seasonal variations.
 - h. Environmental control.
 - i. Rain days as indicated in Specification Section 01 10 00 Summary.

2. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:
 - a. Submittals.
 - b. Mockups.
 - c. Fabrication.
 - d. Installation.
 - e. Tests and inspections.
 - f. Adjusting.
 - g. Curing.
- E. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual dollar volume of the Work performed as of planned and actual dates used for preparation of payment requests.
- F. Three (3) week, lookahead schedule: Prepare schedule indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:
 1. Unresolved issues.
 2. Unanswered Requests for Information.
 3. Rejected or unreturned submittals.
 4. Notations on returned submittals.
 5. Pending modifications affecting the Work and Contract Time.
 6. Inspections by Authorities Having Jurisdiction (AHJ).
 7. Trade pre-installation conference.
- G. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.
- H. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.
- I. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time impact analysis to demonstrate the effect of the proposed change on the overall project schedule.
- J. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:
 1. Identification of activities that have changed.
 2. Changes in early and late start dates.
 3. Changes in early and late finish dates.
 4. Changes in activity durations in workdays.
 5. Changes in the critical path.
 6. Changes in total float or slack time.
 7. Changes in the Contract Time.

2.2 REPORTS

- A. Daily Construction Reports: Prepare a daily construction report recording information concerning events at the site and submit each month to Architect:
 1. List of subcontractors at Project site.
 2. List of separate contractors at Project site.
 3. Approximate count of personnel at Project site.
 4. Rental equipment at Project site.
 5. Material deliveries.
 6. High and low temperatures and general weather conditions, including presence of rain or snow.
 7. Accidents.
 8. Meetings and significant decisions.
 9. Unusual events (see special reports).

10. Stoppages, delays, shortages, and losses.
 11. Meter readings and similar recordings.
 12. Emergency procedures.
 13. Orders and requests of Authorities Having Jurisdiction (AHJ).
 14. Change Orders received and implemented.
 15. Construction Change Directives received and implemented.
 16. Services connected and disconnected.
 17. Equipment or system tests and startups.
 18. Partial completions and occupancies.
 19. Substantial Completions authorized.
- B. Material Location Reports: At monthly intervals, prepare and submit a comprehensive list of materials delivered to and stored at site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:
1. Material stored prior to previous report and remaining in storage.
 2. Material stored prior to previous report and since removed from storage and installed.
 3. Material stored following previous report and remaining in storage.
- C. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report and contact Architect Field Representative. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents to Architect Field Representative.
- D. Special Reports: Submit special reports directly to Owner within 24 hours of an occurrence. Distribute copies of report to parties affected by the occurrence.
1. Reporting Unusual Events: When an event of an unusual and significant nature occurs at site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, and response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner & Architect in advance when these events are known or predictable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

- A. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule with a pencil copy of pay application.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
 2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
 3. As the Work progresses, indicate final completion percentage for each activity.
- B. Distribution: Distribute copies of approved schedule to Architect, Owner, separate contractors, testing and inspecting agencies, and interested parties identified by Contractor with a need to know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
 2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs.
 - 2. Periodic construction photographs.
 - 3. Final completion construction photographs.

1.3 SUBMITTALS

- A. Key Plan: Submit key plan of Project site and building with notation of vantage points marked for location and direction of each photograph or video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.
- B. Digital Photographs: Submit image files within three days of taking photographs.
 - 1. Digital Camera: Minimum sensor resolution of 8 megapixels.
 - 2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
 - 3. Identification: Provide the following information with each image description in file metadata tag:
 - a. Name of Project.
 - b. Name and contact information for photographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photograph was taken.
 - f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.
- C. Construction Photographs: Submit two prints of each photographic view within seven days of taking photographs.
 - 1. Format: 8 inches by 10 inches smooth surface matte prints on single weight, commercial grade photographic paper; mounted on card stock to allow a 1 inch (25 mm) wide margin punched for standard three-ring binder.
 - 2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:
 - a. Name of Project.
 - b. Name and contact information for photographers.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date photographs were taken if not date stamped by camera.
 - f. Description of vantage points, indicating location, direction (by compass point), and elevation or story of construction.
 - g. Unique sequential identifier keyed to accompanying key plan.

1.4 QUALITY ASSURANCE

- A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

1.5 USAGE RIGHTS

- A. Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

- A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of 8 megapixels, and at an image resolution of not less than 3200 by 2400 pixels.

PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

- A. Take photographs using the maximum range of depth of field, and that are in focus, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
 - 1. Maintain key plan with each set of construction photographs that identifies each photographic location.
- B. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image editing software.
 - 1. Date and Time: Include date and time in file name for each image.
 - 2. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to Architect.
- C. Preconstruction Photographs: Before commencement of the Work, take photographs of site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Architect.
 - 1. Flag construction limits before taking construction photographs.
 - 2. Take minimum of 20 photographs to show existing conditions adjacent to property before starting the Work.
 - 3. Take minimum of 20 photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
 - 4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
- D. Periodic Construction Photographs: Take minimum of 20 photographs monthly, coinciding with cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.
 - 1. Take photographs as evidence of existing project conditions as follows:
 - a. Site: Take four (4) site aerial photographs at project corners.
 - b. Interior views: Take four (4) minimum interior photographs of each space under construction from differing directions or as required.
 - c. Exterior views: Take two (2) photographs of each elevation.
 - d. Details: Take as required to document concealed conditions, including, but not limited to, underground construction, utility penetrations and installation, steel erection, concrete and masonry reinforcing, waterproofing and flashing, and roofing installation.

- E. Architect Directed Construction Photographs: From time to time, Architect will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.
- F. Final Completion Construction Photographs: Take minimum of 20 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
 - 1. Do not include date stamp.
- G. Final Completion Construction Photographs: Take minimum of 20 color photographs after date of Substantial Completion for submission as project record documents. Architect will inform photographer of desired vantage points.
 - 1. Do not include date stamp.
- H. Additional Photographs: Architect may request photographs in addition to periodic photographs specified. Additional photographs will be paid for by Change Order and are not included in the Contract Sum.
 - 1. Three days' notice will be given, where feasible.
 - 2. In emergency situations, take additional photographs within 24 hours of request.
 - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
 - a. Special events planned at Project site.
 - b. Immediate follow up when on site events result in construction damage or losses.
 - c. Take photographs at fabrication locations away from site.
 - d. Substantial Completion of a major phase or component of the Work.
 - e. Extra record photographs at time of final acceptance.
 - f. Owner's request for special publicity photographs.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.3 DEFINITIONS

- A. Submittals: Written and graphic information and physical samples that require Architect's responsive action or are for information and do not require the architect's action.
- B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.
- C. Portable Document Format (PDF): An open standard file format used for representing documents in a device independent and display resolution independent fixed layout document format.

1.4 SUBMITTALS

- A. Submittal Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Architect and additional time for handling and reviewing submittals required by those corrections.
 - 1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
 - 2. Initial Submittal: Submit concurrently with construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
 - 3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

- A. Architect's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Architect for Contractor's use in preparing submittals.
 - 1. Upon request, Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings and Project record drawings.
 - a. Architect makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 - b. Digital Drawing Software Program: The Contract Drawings are available in Revit.
 - c. Contractor shall execute a data licensing agreement in the form of AIA Document C106, Digital Data Licensing Agreement.

- d. The following digital data files will be furnished for each appropriate discipline:
 - 1) Floor plans.
 - 2) Reflected ceiling plans.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Submit submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
 - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
 - 4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
 - a. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow time for submittal review, including time for resubmittals. Time for review shall commence on Architect's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.
 - 1. Initial Review: Allow ten (10) days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination.
 - 2. Intermediate Review: If intermediate submittal is necessary, process in same manner as initial submittal.
 - 3. Resubmittal Review: Allow ten (10) days for review of each resubmittal.
 - 4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.
 - 5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Architect and to Architect's consultants, allow ten (10) days for review of each submittal. Submittal will be returned to Architect before being returned to Contractor.
- D. Electronic Submittals: Identify and incorporate information in each electronic submittal file:
 - 1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
 - 2. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Architect.
 - 3. Transmittal Form for Electronic Submittals: Use software generated form from electronic project management software acceptable to Owner, containing the following information:
 - a. Project name.
 - b. Date.
 - c. Name and address of Architect.
 - d. Name of Construction Manager.
 - e. Name of Contractor.
 - f. Name of firm or entity that prepared submittal.
 - g. Names of subcontractor, manufacturer, and supplier.
 - h. Category and type of submittal.
 - i. Submittal purpose and description.
 - j. Specification Section number and title.
 - k. Specification paragraph number or drawing designation and generic name for each of multiple items.

- I. Drawing number and detail references, as appropriate.
 - m. Location(s) where product is to be installed, as appropriate.
 - n. Related physical samples submitted directly.
 - o. Indication of full or partial submittal.
 - p. Transmittal number, numbered consecutively.
 - q. Submittal and transmittal distribution record.
 - r. Other necessary identification.
 - s. Remarks.
4. Metadata: Include the following information as keywords in the electronic submittal file metadata:
 - a. Project name.
 - b. Number and title of appropriate Specification Section.
 - c. Manufacturer name.
 - d. Product name.
- E. Options: Identify options requiring selection by Architect.
- F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.
- G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
 1. Note date and content of previous submittal.
 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
 3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.
- H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

PART 2 - PRODUCTS

2.1 SUBMITTAL PROCEDURES

- A. Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.
 1. Submit electronic submittals via email as PDF electronic files.
 - a. Architect will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.
 2. Certificates and Certifications Submittals: Provide statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 - a. Provide a digital signature with digital certificate on electronically submitted certificates and certifications where indicated.
 - b. Provide a notarized statement on original paper copy certificates and certifications where indicated.

- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's catalog cuts.
 - b. Manufacturer's product specifications.
 - c. Standard color charts.
 - d. Statement of compliance with specified referenced standards.
 - e. Testing by recognized testing agency.
 - f. Application of testing agency labels and seals.
 - g. Notation of coordination requirements.
 - h. Availability and delivery time information.
 4. For equipment, include the following in addition to the above, as applicable:
 - a. Wiring diagrams showing factory installed wiring.
 - b. Printed performance curves.
 - c. Operational range diagrams.
 - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
 5. Submit Product Data before or concurrent with Samples.
 6. Submit Product Data in PDF electronic file.
- C. Shop Drawings: Prepare Project specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
 - a. Identification of products.
 - b. Schedules.
 - c. Compliance with specified standards.
 - d. Notation of coordination requirements.
 - e. Notation of dimensions established by field measurement.
 - f. Relationship and attachment to adjoining construction clearly indicated.
 - g. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full size drawings, submit Shop Drawings on sheet size indicated in specification section.
 3. Submit Shop Drawings in PDF electronic file.
 4. BIM File Incorporation: Develop and incorporate Shop Drawing files into Building Information Model established for Project.
 - a. Prepare Shop Drawings in same digital data software program, version, and operating system as the original Drawings.
 - b. Refer to Section 01 31 00 for requirements for coordination drawings.
- D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
 2. Identification: Attach label on unexposed side of Samples that includes the following:
 - a. Generic description of Sample.
 - b. Product name and name of manufacturer.
 - c. Sample source.

- d. Number and title of applicable Specification Section.
 - e. Specification paragraph number and generic name of each item.
- 3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.
- 4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
- 5. Samples: Submit full size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 - a. Key Items Review Time: Submit samples to the Architect at least 30 days prior to the date the Contractor needs the reviewed submittals returned. The Contractor shall be prepared to submit color samples on any key items in Division 09 finishes within 30 days of the award of Contract. Once samples of all key items are received, the Architect will finalize color selections.
 - b. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.
 - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:
 - 1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 - 2. Manufacturer and product name, and model number if applicable.
 - 3. Number and name of room or space.
 - 4. Location within room or space.
 - 5. Submit product schedule in PDF electronic file.
- F. Coordination Drawing Submittals: Comply with requirements specified in Division 01.
- G. Contractor's Construction Schedule: Comply with requirements specified in Division 01.
- H. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00.
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00.

- J. Closeout Submittals required for Substantial Completion: Comply with requirements specified in Section 01 77 00.
- K. Maintenance Data: Comply with requirements specified in Section 01 78 23.
- L. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- M. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- N. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
- O. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
- P. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- Q. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- R. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
- S. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- T. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- U. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
- V. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

- W. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
- X. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
 - 1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.
- C. BIM File Incorporation: Incorporate delegated design drawing and data files into Building Information Model established for Project.
 - 1. Prepare delegated design drawings in the same digital data software program, version, and operating system as the original Drawings.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

- A. Submittals: Architect will review each submittal, make marks to indicate corrections or revisions required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
- B. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.
- C. Incomplete submittals are not permitted, will be considered nonresponsive, and will be returned for resubmittal without review.

- D. Submittals not required by the Contract Documents will be returned by the Architect without action.

END OF SECTION 01 33 00

SECTION 01 35 16 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Special procedures for alteration Work.

1.3 DEFINITIONS

- A. Alteration Work: This term includes remodeling, renovation, repair, and maintenance work performed within existing spaces or on existing surfaces as part of the Project.
- B. Consolidate: To strengthen loose or deteriorated materials in place.
- C. Design Reference Sample: A sample that represents the Architect's prebid selection of Work to be matched; it may be existing Work or Work specially produced for the Project.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.
- E. Match: To blend with adjacent construction and manifest no apparent difference in material type, species, cut, form, detail, color, grain, texture, or finish; as approved by Architect.
- F. Refinish: To remove existing finishes to base material and apply new finish to match original, or as otherwise indicated.
- G. Repair: To correct damage and defects, retaining existing materials, features, and finishes. This includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials.
- H. Replace: To remove, duplicate, and reinstall entire item with new material. The original item is the pattern for creating duplicates unless otherwise indicated.
- I. Replicate: To reproduce in exact detail, materials, and finish unless otherwise indicated.
- J. Reproduce: To fabricate a new item, accurate in detail to the original, and from either the same or a similar material as the original, unless otherwise indicated.
- K. Retain: To keep existing items that are not to be removed or dismantled.
- L. Strip: To remove existing finish down to base material unless otherwise indicated.

1.4 COORDINATION

- A. Alteration Work Subschedule: A construction schedule coordinating the sequencing and scheduling of alteration Work for entire Project, including each activity to be performed, and based on Contractor's Construction Schedule. Secure time commitments for performing critical construction activities from separate entities responsible for alteration Work.
 - 1. Schedule construction operations in sequence required to obtain best Work results.
 - 2. Coordinate sequence of alteration Work activities to accommodate the following:

- a. Owner's continuing occupancy of portions of existing building.
 - b. Owner's partial occupancy of completed Work.
 - c. Other known Work in progress.
 - d. Tests and inspections.
 3. Detail sequence of alteration Work, with start and end dates.
 4. Utility Services: Indicate how long utility services will be interrupted. Coordinate shutoff, capping, and continuation of utility services.
 5. Use of elevator and stairs.
 6. Equipment Data: List gross loaded weight, axle-load distribution, and wheel base dimension data for mobile and heavy equipment proposed for use in existing structure. Do not use such equipment without certification from Contractor's professional engineer that the structure can support the imposed loadings without damage.
- B. Pedestrian and Vehicular Circulation: Coordinate alteration Work with circulation patterns within Project building(s) and site. Some Work is near circulation patterns and adjacent to restricted areas. Circulation patterns cannot be closed off entirely and in places can be only temporarily redirected around small areas of Work. Access to restricted areas may not be obstructed. Plan and execute the Work accordingly.

1.5 PROJECT MEETINGS FOR ALTERATION WORK

- A. Preliminary Conference for Alteration Work: Before commencing alteration Work, conduct conference at site.
- B. Coordination Meetings: Conduct coordination meetings specifically for alteration Work at regular intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.
 1. Review items of significance that affect progress of alteration Work.
 - a. Interface requirements of alteration work with other Project Work.
 - b. Status of submittals for alteration Work.
 - c. Access to alteration work locations.
 - d. Effectiveness of fire prevention plan.
 - e. Quality and work standards of alteration Work.
 - f. Change Orders for alteration Work.
 2. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

1.6 MATERIALS OWNERSHIP

- A. Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to Owner that may be encountered or uncovered during the Work, regardless of whether they were previously documented, remain Owner's property.
 1. Carefully dismantle and salvage each item or object in a manner to prevent damage and protect it from damage, then promptly deliver it to Owner where directed.
- B. Alteration Work Subschedule: Submit alteration Work subschedule within seven days of date established for commencement of alteration Work.
- C. Preconstruction Documentation: Show preexisting conditions of adjoining construction and site improvements that are to remain, including finish surfaces, that might be misconstrued as damage caused by Contractor's alteration Work operations.
- D. Alteration Work Program: Submit 30 days before Work begins.

- E. Fire Prevention Plan: Submit 30 days before Work begins.

1.7 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Building Code: Comply with the IBC and the IEBC for alteration Work.
 2. Fire Prevention Plan: Prepare a written plan for preventing fires during the Work, including placement of fire extinguishers, fire blankets, rag buckets, and other fire control devices during each phase or process. Coordinate plan with Owner's fire protection equipment and requirements. Include fire watch personnel's training, duties, and authority to enforce fire safety.
 3. Safety and Health Standard: Comply with ANSI/ASSE A10.6.
 4. Title X Requirement: Each firm conducting activities that disturb painted surfaces shall be a *Lead-Safe Certified Firm* according to 40 CFR 745, Subpart E, and use only workers that are trained in lead safe Work practices.
 5. Accessibility Requirements: Comply with applicable requirements.
 - a. U.S. Architectural and Transportation Barriers Compliance Board Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).
 - b. ICC/ANSI A117.1 Accessible and Useable Building and Facilities.
 - c. Texas Accessibility Standards (TAS).
- B. Specialist Qualifications: An experienced firm having minimum 10 years documented experience that is regularly engaged in specialty Work similar in nature, materials, design, and extent to alteration Work specified.
1. Field Supervisor Qualifications: Full time supervisors experienced in specialty Work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on site when specialty Work begins and during its progress. Supervisors shall not be changed during Project except for causes beyond the control of the specialist firm.
 - a. Construct new mockups of required Work whenever a supervisor is replaced.
- C. Alteration Work Program: Prepare a written plan for alteration Work for whole Project, including each phase or process and protection of surrounding materials during operations. Show compliance with indicated methods and procedures specified in this and other Sections. Coordinate this whole Project alteration Work program with specific requirements of programs required in other alteration Work Sections.
1. Dust and Noise Control: Include locations of proposed temporary dust and noise control partitions and means of egress from occupied areas coordinated with continuing on site operations and other known Work in progress.
 2. Debris Hauling: Include plans clearly marked to show debris hauling routes, turning radii, and locations and details of temporary protective barriers.

1.8 STORAGE AND HANDLING OF SALVAGED MATERIALS

- A. Salvaged Materials:
1. Clean loose dirt and debris from salvaged items unless more extensive cleaning is indicated.
 2. Pack or crate items after cleaning; cushion against damage during handling. Label contents of containers.
 3. Store items in a secure area until delivery to Owner.
 4. Transport items to Owner's storage area designated by Owner.
 5. Protect items from damage during transport and storage.
- B. Salvaged Materials for Reinstallation:
1. Repair and clean items for reuse as indicated.

2. Pack or crate items after cleaning and repairing; cushion against damage during handling. Label contents of containers.
 3. Protect items from damage during transport and storage.
 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment unless otherwise indicated. Provide connections, supports, and miscellaneous materials to make items functional for use indicated.
- C. Existing Materials to Remain: Protect construction indicated to remain against damage and soiling from construction Work. Where permitted by Architect, items may be dismantled and taken to a suitable, protected storage location during construction Work and reinstalled in their original locations after alteration and other construction work in the vicinity is complete.
- D. Storage: Catalog and store items within a weathertight enclosure where they are protected from moisture, weather, condensation, and freezing temperatures.
1. Identify each item for reinstallation with a nonpermanent mark to document its original location. Indicate original locations on plans, elevations, sections, or photographs by annotating the identifying marks.
 2. Secure stored materials to protect from theft.
 3. Control humidity so that it does not exceed 85 percent. Maintain temperatures 5 degrees F (3 degrees C) or more above the dew point.
- E. Storage Space:
1. Owner will arrange for limited on site location(s) for free storage of salvaged material. Storage space **[includes]** **[does not include]** security and climate control for stored material.
 2. Arrange for off-site locations for storage, protection, and insurance coverage of salvaged material that cannot be stored and protected on site.

1.9 FIELD CONDITIONS

- A. Survey of Existing Conditions: Record existing conditions that affect the Work by use of preconstruction photographs.
- B. Discrepancies: Notify Architect of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling Work.
- C. Owner's Removals: Before beginning alteration Work, verify in correspondence with Owner that the following items have been removed:
- D. Size Limitations in Existing Spaces: Materials, products, and equipment used for performing the work and for transporting debris, materials, and products shall be of sizes that clear surfaces within existing spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from alteration Work.
1. Use proven protection methods, appropriate to each area and surface being protected.
 2. Provide temporary barricades, barriers, and directional signage to exclude the public from areas where alteration Work is being performed.

3. Erect temporary barriers to form and maintain fire egress routes.
 4. Erect temporary protective covers over walkways and at points of pedestrian and vehicular entrance and exit that must remain in service during alteration Work.
 5. Contain dust and debris generated by alteration Work, and prevent it from reaching the public or adjacent surfaces.
 6. Provide shoring, bracing, and supports as necessary. Do not overload structural elements.
 7. Protect floors and other surfaces along hauling routes from damage, wear, and staining.
 8. Provide supplemental sound control treatment to isolate demolition Work from other areas of the building.
- B. Temporary Protection of Materials to Remain:
1. Protect existing materials with temporary protections and construction. Do not remove existing materials unless otherwise indicated.
 2. Do not attach temporary protection to existing surfaces except as indicated as part of the alteration work program.
- C. Comply with each product manufacturer's written instructions for protections and precautions. Protect against adverse effects of products and procedures on people and adjacent materials, components, and vegetation.
- D. Utility and Communications Services:
1. Notify Owner, Architect, authorities having jurisdiction, and entities owning or controlling wires, conduits, pipes, and other services affected by alteration Work before commencing operations.
 2. Disconnect and cap pipes and services as required by authorities having jurisdiction, as required for alteration Work.
 3. Maintain existing services unless otherwise indicated; keep in service, and protect against damage during operations. Provide temporary services during interruptions to existing utilities.
- E. Existing Drains: Prior to the start of Work in an area, test drainage system to ensure that it is functioning properly. Notify Architect immediately of inadequate drainage or blockage. Do not begin Work in an area until the drainage system is functioning properly.
1. Prevent solids such as adhesive or mortar residue or other debris from entering the drainage system. Clean out drains and drain lines that become sluggish or blocked by sand or other materials resulting from alteration Work.
 2. Protect drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
- F. Existing Roofing: Prior to the start of Work in an area, install roofing protection.

3.2 PROTECTION FROM FIRE

- A. Follow fire prevention plan and the following:
1. Comply with NFPA 241 requirements unless otherwise indicated.
 2. Remove and keep area free of combustibles, including rubbish, paper, waste, and chemicals, unless necessary for the immediate Work.
 - a. If combustible material cannot be removed, provide fire blankets to cover materials.
- B. Heat Generating Equipment and Combustible Materials: Comply with procedures while performing Work with heat generating equipment or combustible materials, including welding, torch cutting, soldering, brazing, removing paint with heat, or other operations where open flames or implements using high heat or combustible solvents and chemicals are anticipated:

1. Obtain Owner's approval for operations involving use of [**open flame or**] welding or other high heat equipment.[**Use of open flame equipment is not permitted.**] Notify Owner [at least 72 hours] before each occurrence, indicating location of such Work.
 2. As far as practicable, restrict heat generating equipment to shop areas or outside the building.
 3. Do not perform Work with heat generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use a combustible gas indicator test to ensure that the area is safe.
 4. Use fireproof baffles to prevent flames, sparks, hot gases, or other high-temperature material from reaching surrounding combustible material.
 5. Prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
 6. Fire Watch: Before Working with heat generating equipment or combustible materials, station personnel to serve as a fire watch at each location where Work is performed. Firewatch personnel shall have the authority to enforce fire safety. Station fire watch according to NFPA 51B, NFPA 241, and as follows:
 - a. Train each fire watch in the proper operation of fire control equipment and alarms.
 - b. Prohibit firewatch personnel from other Work that would be a distraction from firewatch duties.
 - c. Cease Work with heat generating equipment whenever fire watch personnel are not present.
 - d. Have fire watch personnel perform final fire safety inspection each day beginning no sooner than [30 minutes] after conclusion of Work [in each area] to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
 - e. Maintain fire watch personnel at [each area of] site until [60 minutes] [two hours] after conclusion of daily Work.
- C. Fire Control Devices: Provide and maintain fire extinguishers, fire blankets, and rag buckets for disposal of rags with combustible liquids. Maintain each as suitable for the type of fire risk in each Work area. Ensure that nearby personnel and the fire-watch personnel are trained in fire-extinguisher and blanket use.
- D. Sprinklers: Where sprinkler protection exists and is functional, maintain it without interruption while operations are being performed. If operations are performed close to sprinklers, shield them temporarily with guards.
1. Remove temporary guards at the end of Work shifts, whenever operations are paused, and when nearby Work is complete.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

- A. Protect motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm or spillage resulting from applications of chemicals and adhesives.
- B. Cover adjacent surfaces with protective materials that are proven to resist chemicals selected for Project unless chemicals being used will not damage adjacent surfaces as indicated in alteration Work program. Use covering materials and masking agents that are waterproof and UV resistant and that will not stain or leave residue on surfaces to which they are applied. Apply protective materials according to manufacturer's written instructions. Do not apply liquid masking agents or adhesives to painted or porous surfaces. When no longer needed, promptly remove protective materials.
- C. Do not apply chemicals during winds of sufficient force to spread them to unprotected surfaces.
- D. Neutralize alkaline and acid wastes and legally dispose of off Owner's property.

- E. Collect and dispose of runoff from chemical operations by legal means and in a manner that prevents soil contamination, soil erosion, undermining of paving and foundations, damage to landscaping, or water penetration into building interior.

3.4 ALTERATION WORK

- A. Have specialty Work performed only by qualified specialists.
- B. Ensure that supervisory personnel are present when Work begins and during its progress.
- C. Record existing Work before each procedure (preconstruction), and record progress during the Work. Use digital preconstruction documentation photographs or video recordings. Comply with requirements in Section 01 32 33.
- D. Perform surveys of site as the Work progresses to detect hazards resulting from alterations.
- E. Notify Architect of visible changes in the integrity of material or components whether from environmental causes including biological attack, UV degradation, freezing, or thawing or from structural defects including cracks, movement, or distortion.
 - 1. Do not proceed with the Work in question until directed by Architect.

END OF SECTION 01 35 16

SECTION 01 35 46 - INDOOR AIR QUALITY PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Construction procedures to promote adequate indoor air quality after construction.
- B. Testing indoor air quality after completion of construction.

1.2 PROJECTS GOALS

- A. Dust and Airborne Particulates: Prevent deposition of dust and other particulates in HVAC ducts and equipment.
 - 1. Cleaning of ductwork is not contemplated under this Contract.
 - 2. Contractor shall bear the cost of cleaning required due to failure to protect ducts and equipment from construction dust.
 - 3. Establish condition of existing ducts and equipment prior to start of alterations.
- B. Airborne Contaminants: Procedures and products have been specified to minimize indoor air pollutants.
 - 1. Furnish products meeting the specifications.
 - 2. Avoid construction practices that could result in contamination of installed products leading to indoor air pollution.
- C. Verification: HVAC system has been designed to achieve the minimum requirements for ventilation specified in ASHRAE 62.1, with verification provided by MEP Engineer of Record.

1.3 RELATED WORK

- A. Section 01 81 13 – LEED Requirements: LEED credits relating to indoor air quality.
- B. Section 01 40 00 – Quality Requirements: Testing and inspection services.
- C. Section 01 60 00 – Product Requirements: Volatile Organic Compound (VOC) Content Restrictions.
- D. Section 23 81 26 – Split-System DX Air-Handling Units: HVAC filters.
- E. Section 23 05 93 – Air Conditioning and Ventilation Test and Balance: Testing HVAC systems for proper air flow rates, adjustment of dampers and registers, and settings for equipment.

1.4 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 – Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size: 2007.
- B. ASHRAE Std 62.1 – Ventilation For Acceptable Indoor Air Quality: 2007 (errata 2008).
- C. ASHRAE Std 129 – Measuring Air-Change Effectiveness: 1997 (Reaffirmed 2002).

- D. ASTM E 779 – Standard Test Method for Determining Air Leakage Rate by Fan Pressurization: 2003.
- E. CAL (EESR) – California Energy Efficiency Standards Residential Alternative Calculation
- F. SMACNA (OCC) – IAQ Guideline for Occupied Buildings Under Construction: 2007.

1.5 DEFINITIONS

- A. Adsorptive Materials: Gypsum board, acoustical ceiling tile and panels, carpet and carpet tile, fabrics fibrous insulation, and other similar products.
- B. Contaminants: Gases, vapors, regulated pollutants, airborne mold and mildew, and the like, as specified.
- C. Particulates: Dust, dirt, and other airborne solid matter.
- D. West Work: Concrete, plaster, coatings, and other products that emit water vapor or volatile organic compounds during installation, drying, or curing.

1.6 SUBMITTALS (Provided by Owner's Commissioning Agent)

- A. See Section 01 30 00 – Submittal Procedures: Submittal procedures.
- B. Indoor Air Quality Management Plan: Describe in detail measures to be taken to promote adequate indoor air quality upon completion; use SMACNA IAQ Guidelines for Occupied Buildings Under Construction as a guide. Work shall be performed per LEED credit 3.1: Indoor Air Quality Management, During Construction & AEGB credit 11: Construction Indoor Air Quality (Submit prior to preconstruction meeting).
 - 1. Submit not less than 60 days before enclosure of building.
 - 2. Identify potential sources of odor and dust.
 - 3. Identify construction activities likely to produce odor or dust.
 - 4. Identify areas of project potentially affected, especially occupied areas.
 - 5. Evaluate potential problems by severity and describe methods of control.
 - 6. Describe construction ventilation to be provided, including type and duration of ventilation, use of permanent HVAC systems, types of filters and schedule for replacement of filters.
 - 7. Describe cleaning and dust control procedures.
 - 8. Describe measures to be taken for protection of absorptive materials.
 - 9. Outline requirement for filtration for air handling equipment used during construction to use media with a minimum of MERV 8 at each return grill if permanently installed air handlers used during construction."
- C. Interior Finishes Installation Schedule: Identify each interior finish that either generates odors, moisture, or vapors or is susceptible to adsorption of odors and vapors, and indicate air handling zone, sequence of application, and curing times.
- D. Duct and Terminal Unit Inspection Report.
- E. Air Contaminant Test Plan: Identify:
 - 1. Testing agency qualifications.
 - 2. Locations and scheduling of air sampling.
 - 3. Test procedures, in detail.
 - 4. Test instruments and apparatus.
 - 5. Sampling methods.
- F. Air Contaminant Test Reports: Show

1. Location where each sample was taken, and time.
 2. Test Values for each air sample; average the values of each set of 3.
 3. HVAC operating conditions.
 4. Certification of test equipment calibration.
 5. Other conditions or discrepancies that might have influenced results.
- G. Ventilation Effectiveness Test Plan: Identify:
1. Testing agency qualifications.
 2. Description of test spaces, including locations or air sampling.
 3. Test procedures, in detail; state whether tracer gas decay or step-up-will be used.
 4. Test instruments and apparatus; identify tracer gas to be used.
 5. Sampling methods.
- H. Ventilation Effectiveness Test Reports: Show:
1. Include preliminary tests of instruments and apparatus and of test spaces.
 2. Calculation of ventilation effectiveness, E.
 3. Location where each sample was taken, and time.
 4. Test values for each air sample.
 5. HVAC operating conditions.
 6. Other information specified in ASHRAE 129.
 7. Other conditions or discrepancies that might have influenced results.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Low VOC Materials: See other sections for specific requirements for materials with low VOC content.
- B. Auxiliary Air Filters: MERV of 8, minimum, when tested in accordance with ASHRAE 52.2.

PART 3 – EXECUTION

3.1 CONSTRUCTION PROCEDURES

- A. Prevent the absorption of moisture and humidity by adsorptive materials by:
1. Sequencing the delivery of such materials so that they are not present in the building until wet Work is completed and dry.
 2. Delivery and storage of such materials in fully sealed moisture-impermeable packaging.
 3. Provide sufficient ventilation for drying within reasonable time frame.
- B. Begin construction ventilation when building is substantially enclosed.
- C. If extremely dusty or dirty Work must be conducted inside the building, shut down HVAC systems for the duration; remove dust and dirt completely before restarting systems.
- D. HVAC equipment and supply air ductwork may be used for ventilation during construction:
1. Operate HVAC system on 100 percent outside air, with 1.5 air changes per hour, minimum.
 2. Ensure that air filters are correctly installed prior to starting use; replace filters when they lose efficiency (for Corridor HVAC only).
 3. Do not use return air ductwork for ventilation.
 4. Seal return air inlets or otherwise positively isolate return air system to prevent recirculation of air; provide alternate return air pathways (for Corridor HVAC only).
- E. Do not store construction materials or waste in mechanical or electrical rooms.

- F. Prior to use of return air ductwork without intake filters clean up and remove dust and debris generated by construction activities.
 - 1. Inspect duct intakes, return air grilles, and terminal units for dust.
 - 2. Clean plenum spaces, including top sides of lay-in ceilings, outsides of ducts, tops of pipes and conduit.
 - 3. Clean tops of doors and frames.
 - 4. Clean mechanical and electrical rooms, including tops of pipes, ducts, and conduit, equipment, and supports.
 - 5. Clean return plenums of air handling units.
 - 6. Remove intake filters last, after cleaning is complete.
- G. Do not perform dusty or dirty Work after starting use of return air ducts without intake filters.
- H. Use other relevant recommendations of SMACNA IAQ Guideline for Occupied Buildings Under Construction for avoiding unnecessary contamination due to construction procedures.

END OF SECTION 01 35 46

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
 - 4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

- A. Quality Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- B. Quality Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Architect.
- C. Mockups: Full size physical assemblies that are constructed on-site. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Laboratory Mockups: Full size physical assemblies constructed at testing facility to verify performance characteristics.
 - 2. Integrated Exterior Mockups: Mockups of exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
 - 3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

- D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- F. Source Quality Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- G. Field Quality Control Testing: Tests and inspections performed on site for installation of the Work and for completed Work.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform particular construction operations, including installation, erection, application, and similar operations.
 - 1. Use of trade specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).
- J. Experienced: When used with an entity or individual, *experienced* means having successfully completed a minimum of five years documented experience with projects similar in nature, size, and extent; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.4 CONFLICTING REQUIREMENTS

- A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

- A. Shop Drawings: Submit plans, sections, and elevations, indicating materials and size of mockup construction.
 - 1. Indicate manufacturer and model number of individual components.
 - 2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.
- B. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting Work on the following systems:
 - 1. Seismic force resisting system, designated seismic system, or component listed in the designated seismic system quality assurance plan prepared by Architect.
 - 2. Main wind force resisting system or wind resisting component listed in the wind force resisting system quality assurance plan prepared by Architect.

- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
1. Specification Section number and title.
 2. Entity responsible for performing tests and inspections.
 3. Description of test and inspection.
 4. Identification of applicable standards.
 5. Identification of test and inspection methods.
 6. Number of tests and inspections required.
 7. Time schedule or time span for tests and inspections.
 8. Requirements for obtaining samples.
 9. Unique characteristics of each quality control service.

1.6 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
1. Date of issue.
 2. Project title and number.
 3. Name, address, and telephone number of testing agency.
 4. Dates and locations of samples and tests or inspections.
 5. Names of individuals making tests and inspections.
 6. Description of the Work and test and inspection method.
 7. Identification of product and Specification Section.
 8. Complete test or inspection data.
 9. Test and inspection results and an interpretation of test results.
 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 12. Name and signature of laboratory inspector.
 13. Recommendations on retesting and reinspecting.
- B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of technical representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at site comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- C. Factory Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory authorized service representative's tests and inspections specified in other Sections. Include the following:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement that equipment complies with requirements.
 3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 4. Statement whether conditions, products, and installation will affect warranty.
 5. Other required items indicated in individual Specification Sections.

- D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
- E. Trade Preinstallation Conferences: Meeting minutes to be Contractor provided.

1.7 QUALITY ASSURANCE

- A. Qualifications establish the minimum qualification levels required; refer to individual Specification Sections for additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated and sufficient production capacity to produce required units.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated and with record of successful in service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling Work similar in material, design, and extent to that indicated for this Project, whose Work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Texas, experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated.
- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products.
- I. Factory Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens with sufficient time for testing and analyzing results to prevent delaying the Work.

- c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
 - f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.
- 2. Testing Agency Responsibilities: Submit certified written report of each test, inspection, and similar quality assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
 - 1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect.
 - 2. Notify Architect a minimum of seven days in advance of dates and times when mockups will be constructed.
 - 3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction.
 - 4. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 5. Obtain Architect's approval of mockups before starting Work, fabrication, or construction. Allow **seven** days for initial review and each re-review of each mockup.
 - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed unless otherwise indicated.
- L. Integrated Exterior Mockups: Mockup of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies shall be constructed. Mockup, if not specifically shown on the drawings, shall be minimum 8'x8'. Mockup shall include all major façade elements and at least one window minimum 2'x2' in size. Prior to constructing mockup verify requirements with architect. Pre-installation conferences for trades involved in Integrated Exterior Mockup shall be held after mockup is completed.
- M. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Specification Sections.
- N. Trade Preinstallation Conferences: Meeting minutes to be Contractor provided.

1.8 QUALITY CONTROL

- A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
1. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
 2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
 4. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
 5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Manufacturer's Field Services: Where indicated, engage a factory authorized service representative to inspect field assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300.
- D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.
- E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- F. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
1. Access to the Work.
 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storage and field curing of test samples.
 5. Delivery of samples to testing agencies.

6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.9 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner:
- B. Special Tests and Inspections: Conducted by a qualified testing agency or special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections.
1. Verifying that manufacturer maintains detailed fabrication and quality control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
 2. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 3. Submitting a certified written report of each test, inspection, and similar quality control service to Architect with copy to Contractor and to authorities having jurisdiction.
 4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
 6. Retesting and reinspecting corrected Work.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 REPAIR AND PROTECTION

- A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00.
- B. Protect construction exposed by or for quality control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK REQUIREMENTS

- A. General: This Section specifies procedural and administrative requirements for compliance with governing regulations and codes and standards imposed upon the Work. These requirements include the obtaining of permits, licenses, inspections, releases, and similar statements, as well as payments, associated with regulations, codes, and standards.
- B. "Regulations" is defined to include laws, statutes, ordinances, and lawful orders issued by governing authorities, as well as those rules, conventions and agreements within the construction industry which effectively control the performance of the Work regardless of whether they are lawfully imposed by governing authority or not.
- C. Governing Regulations: Refer to General and Supplementary Conditions for requirements related to compliance with governing regulations.

1.3 DEFINITIONS

- A. General: Basic Contract definitions are included in the Conditions of the Contract.
- B. "Approved": When used to convey Architect's action on Contractor's submittals, applications, and requests, "approved" is limited to Architect's duties and responsibilities as stated in the Conditions of the Contract.
- C. "Directed": A command or instruction by Architect. Other terms including "requested," "authorized", "selected", "required", and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown", "noted", "scheduled", and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

- J. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project Site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.4 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference. Individual Specification Sections indicate which codes and standards the Contractor must keep available at the project site for reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
- C. Conflicting Requirements: Where compliance with two or more standards is specified, and where these standards establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents specifically indicate a less stringent requirement. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Architect/Engineer for a decision before proceeding.
- D. Minimum Quantities or Quality Levels: In every instance the quantity or quality level shown or specified is intended to be the minimum for the Work to be provided or performed. Unless otherwise indicated, the actual Work may either comply exactly, within specified tolerances, with the minimum quantity or quality specified, or may exceed that minimum within reasonable limits. In complying with these requirements, the indicated numeric values are either minimum or maximum values, as noted, or as appropriate for context of the requirements. Refer instances of uncertainty to the Architect/Engineer for decision before proceeding.

1.5 ABBREVIATIONS AND ACRONYMS

- A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the trade association, standards-producing organization, authorities having jurisdiction or other entity applicable to the context of the text provision.
- B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the Agency.
- C. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations.

1.6 SUBMITTALS

- A. Permits, Licenses and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence, and records established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

PART 2 - PRODUCTS

Not Used

BEAM Professionals
Project No. 250373
Issue For Proposal

Cunningham Middle School and North Shore Middle School
Galena Park Independent School District
December 05, 2025

PART 3 - EXECUTION

Not Used

END OF SECTION 01 42 00

SECTION 01 45 23 - TESTING AND INSPECTING SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Requirements and qualifications including but not limited to:
 - 1. Professional testing and laboratory services.
 - 2. Accessories necessary for the completion of testing and laboratory services.
- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with Contract Document requirements.
 - 3. Requirements for Contractor to provide quality assurance and quality control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions.
 - 4. Specific test and inspection requirements are not specified in this Section.
- C. A qualified independent testing laboratory and/or geotechnical engineering service selected and paid by Owner.
 - 1. The Owner will pay for the initial laboratory services of materials that comply with the requirements of the Contract Documents. The Contractor shall pay for testing and retesting of materials that do not comply with the requirements of the Contract Documents.
- D. Inspecting agency shall perform inspections and tests in accordance with the rules and regulations of the building code, local authorities, Specifications of ASTM, and the Contract Documents.
- E. Materials and workmanship found not in compliance with required standards or performance obligations shall be removed and replaced. Replacement and subsequent testing shall be at Contractor's expense.
- F. Where terms "Inspector" and "Laboratory" are used, it is meant and in reference to an officially designated and accredited inspector of the testing laboratory or geotechnical service engaged by Owner.
- G. Laboratory inspections shall not relieve the Contractor or Fabricator of his responsibility to furnish materials and workmanship in accordance with the Contract Documents.
- H. Contractor or Fabricator shall cooperate with the testing laboratory in matters pertaining to the Work.
- I. Contractor to address deficiency and failed reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, documented according to ASTM E 329 and ASTM E534; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
 - 1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
 - 2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.
 - 3. Testing agencies shall be insured against errors and omissions by a professional liability insurance policy having a minimum limit of liability of \$1,000,000.00.
- B. Inspection and testing services of the testing agency shall be under the direction of a Registered Engineer licensed in the State of Texas, charged with engineering managerial responsibility, and having a minimum of five (5) years engineering experience in inspection and testing of construction materials.
- C. Structural Steel: Primary inspectors performing structural steel inspection shall be currently certified AWS Certified Welding Inspectors (CWI), in accordance with the provisions of AWS QCI, *Standard and Guide for Qualification and Certification of Welding Inspectors*.
 - 1. Inspector may be supported by assistant inspectors who perform specific inspection functions under the direct supervision of the Primary Inspector. Assistant inspectors shall be currently certified AWS Certified Associate Welding Inspectors (CAWI). Work of assistant inspectors shall be monitored daily by the inspector.
- D. Testing Equipment: Equipment shall be calibrated at intervals not exceeding 12 months by devices of accuracy traceable to the National Bureau of Standards.
- E. Referenced Standards: Latest adopted edition of standards referenced apply to the Work. In the event of conflict between the Contract Documents and referenced standards, the Contract Documents shall govern. In case of conflict between Contract Documents and the Building Code, the more stringent shall govern.

1.4 QUALITY CONTROL

- A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform the services.
 - 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
 - 2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with requirements, whether specified or not.
 - 1. Refer to the individual specification sections for specific requirements.
 - 2. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
 - 3. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform the quality control services. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 - 4. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.

5. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality control service.
 6. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 7. Submit additional copies of each written report directly to authorities having jurisdiction, when they are so direct.
 8. Associated Responsibilities and Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notifying agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - a. Provide access to the Work.
 - b. Delivery of samples to testing laboratory, without cost to Owner, in adequate quantities of representative samples of materials that require testing and inspecting. Assisting agency in obtaining samples.
 - c. Advise laboratory and Architect sufficiently in advance of construction operations to allow laboratory to complete required inspections or tests and to assign personnel for field inspection and testing as specified.
 - d. Incidental labor, facilities, and equipment necessary to assist laboratory personnel in obtaining and handling samples at the site.
 - e. Obtain required inspections or approvals of the building official. Inspection requests and notifications required by building code are responsibility of the Contractor.
 - f. Provide current welder certificates for each welder employed.
 - g. Security and protection for samples and for testing and inspecting equipment at Project site.
 9. Retesting/Reinspecting: Regardless of payment responsibility of the original tests or inspections, provide quality control services, including retesting and reinspecting, for construction that replaced Work failing to comply with the Contract Documents or Code requirements.
- C. Testing Agency Responsibilities: Cooperate with Architect and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
1. Notify Architect and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
 2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
 3. Conduct and interpret tests and inspections and state in each report whether tested and inspected Work complies with or deviates from requirements.
 4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
 5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
 6. Do not perform any duties of Contractor.
- D. Coordination: Coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.5 AUTHORITY AND DUTIES OF LABORATORY PERSONNEL

- A. A representative of the testing laboratory, who has reviewed and is familiar with the project and specifications, shall participate in preconstruction conferences. The representative shall coordinate material testing and inspection requirements with the Contractor and its

subcontractors consistent with the planned construction schedule. The laboratory representative shall attend conferences required or requested to address quality control issues.

- B. Laboratory personnel shall inspect and test materials, assemblies, specimens, and Work performed, including methods and techniques and report the progress to the Architect.
- C. If material or Work fails to meet requirements of Contract Documents, laboratory inspector shall notify the Project Manager, Architect, Engineers, supplier or subcontractor providing or preparing the materials or Work being tested of such failure.
- D. Laboratory personnel shall not perform the Work of the Contractor or act as foremen or superintendents. Work will be inspected as it progresses, but failure to detect defective Work or materials shall not prevent later rejection when a defect is discovered.
- E. Laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release the requirements of the Contract Documents or approve or accept portions of Work, except where approval is specifically specified in the Specifications.
- F. Comply with building code requirements for Special Inspections.

1.6 SUBMITTALS

- A. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's construction schedule. Update as the Work progresses.
- B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of tests and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality control service.
- C. Test and Inspection Reports: Prepare and submit certified written reports specified. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, and telephone number of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.
- D. Submit copies of reports of each inspection and test:

1. Owner, Program Manager, Architect, and each Engineer or outside consultants regarding their particular phase of the project: One copy each.
 2. Project Manager and Contractor: Two copies each.
- E. In addition to furnishing a written report, notify Project Manager and Contractor verbally of uncorrected conditions or failures to comply with requirements of the Contract Documents, and immediately email corresponding report to the Architect and Engineer.
- F. At completion of each trade or branch of Work requiring inspecting and testing, submit a final certificate attesting to satisfactory completion of Work and full compliance with requirements of Contract Documents.

1.7 TESTING LABORATORY GUIDELINES AND PROCEDURES

- A. Technician time for services performed will be reimbursed at a regular time rate. Compensation at the overtime rate will be considered for hours over eight hours spent at the site on a single day, field testing services performed on a Saturday or Sunday, and field services performed on a recognized holiday.
- B. There shall be a three hour minimum for each scheduled testing service. Vehicle charges will be included on a \$25.00 per trip basis.
- C. The Contractor shall bear the responsibility of scheduling the testing services. The Contractor and the testing laboratory shall assume full responsibility to coordinate the testing services. Cancellations or failed test shall be reimbursable to the Owner by the responsible party for the cancellations or failure of a test or service.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
1. Date test or inspection was conducted.
 2. Description of the Work tested or inspected.
 3. Date test or inspection results were transmitted to Architect.
 4. Identification of testing agency or special inspector conducting test or inspection.
 5. Deficiency log.
- B. Maintain log at site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.

3.2 TESTING AND INSPECTION SERVICES

- A. Testing services shall include but not be limited to those specified below or which are necessary or required during course of construction to ascertain specification compliance and which may be deemed necessary by Architect, Engineer, or Owner to ensure the quality of the Work.
- B. The Owner reserves the right to add to or delete any or all inspection and testing specified, excluding testing required by the applicable building codes.
- C. If conflicts arise between Drawings and Specifications, notify Architect immediately. The most stringent requirements shall dictate procedure.

3.3 METAL ROOF DECK

- A. Field inspection shall consist of:
 - 1. Verify types, gauges and finishes.

3.4 LIGHTWEIGHT INSULATING CONCRETE FILL

- A. Inspection and Observation Services:
 - 1. Inspection of roof deck prior to start of Work.
 - 2. Inspection during repair of lightweight insulating concrete Work to ascertain compliance with Contract Documents.
 - 3. Observation of base ply fastener pull tests performed by Contractor to ascertain minimum withdrawal resistance of 40 pounds per fastener.
- B. References (As applicable for tests required):
 - a. American Society for Testing and Materials (ASTM)
 - 1) C177 - Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties By Means of the Guarded Hot Plate Apparatus.
 - 2) C495 - Test Method for Compressive Strength of Lightweight Insulating Concrete.

3.5 TESTING OF ROOFING

- A. Inspection and Observation Services (As required):
 - 1. Inspection of roof deck prior to start of Work.
 - 2. Inspect on site condition of stored roofing materials.
 - 3. Inspection during roofing, roof insulation, and sheet metal Work to ascertain compliance with Contract Documents.
 - 4. Observation of roof test cuts performed by Contractor to ascertain that they are properly made.
 - 5. Observation of patching of roof test cuts to ascertain that they are properly made.
- B. Testing Services (As required):
 - 1. Perform dissection and analysis on cuts provided by Contractor to confirm number of plies, bonding of plies, weight of bitumen and softening temperature to ascertain compliance with specifications.

3.6 REPAIR AND PROTECTION

- A. On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or match existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 29.
- B. Protect construction exposed by or for quality control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality control services.

END OF SECTION 01 45 23

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED SECTIONS

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

1.2 SUMMARY

- A. Section Includes: Requirements for temporary utilities, support facilities, and security and protection facilities, including but not limited to:
 - 1. Water service and distribution.
 - 2. Sanitary facilities, including toilets, wash facilities, and drinking water facilities.
 - 3. Heating and cooling facilities.
 - 4. Ventilation.
 - 5. Electric power service.
 - 6. Lighting.
 - 7. Telephone service.
 - 8. Waste disposal facilities.
 - 9. Field office.
 - 10. Storage and fabrication sheds.
 - 11. Lifts and hoists.
 - 12. Construction aids and miscellaneous services and facilities.
 - 13. Environmental protection.
 - 14. Pest control.
 - 15. Enclosure fence.
 - 16. Security enclosure and lockup.
 - 17. Barricades, warning signs, and lights.
 - 18. Temporary partitions.
 - 19. Fire protection.
 - 20. Accessories necessary for a complete installation.

1.3 USE CHARGES

- A. Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Architect, occupants of Project, testing agencies, and authorities having jurisdiction.
- B. Water and Sewer Service: Pay sewer service use charges for water used and sewer usage by all entities for construction operations.
- C. Electric Power Service: Pay electric power service use charges for electricity used by all entities for construction operations.

1.4 SUBMITTALS

- A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Moisture Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage.

1. Describe delivery, handling, and storage provisions for materials subject to water absorption or water damage.
 2. Indicate procedures for discarding water damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water damaged work.
 3. Indicate sequencing of Work that requires water, such as sprayed fire resistive materials, plastering, and tile grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
- C. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust and HVAC control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
1. HVAC system isolation schematic drawing.
 2. Location of proposed air-filtration system discharge.
 3. Waste handling procedures.
 4. Other dust control measures.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board ADA-ABA Accessibility Guidelines (ADAAG), ICC/ANSI A117.1, and Texas Accessibility Standards (TAS) 2012.
- B. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Architect. Provide materials suitable for use intended.
- B. Chain Link Fencing: Minimum 2-inch (50 mm), 0.148-inch (3.8 mm) thick, galvanized steel, chain link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8 inch (60 mm) OD line posts and 2-7/8-inch (73 mm) OD corner and pull posts.
- C. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10 mils (0.25 mm) minimum thickness, with flame spread rating of 15 or less per ASTM E 84.
- D. Dust Control Adhesive Surface Walk off Mats: Provide mats with minimum 36 inches by 60 inches (914 mm by 1624 mm).
- E. Insulation: Unfaced mineral fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame spread and smoke developed indexes of 25 and 50, respectively.

- F. Lumber and Plywood: Comply with requirements in Section 06 10 00.
- G. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; Type X or Type C panels with tapered edges.
- H. Paint: Similar like and kind.
- I. Tarpaulins: Fire resistive labeled with flame-spread rating of 15 or less.
- J. Water: Potable.

2.2 TEMPORARY FACILITIES

- A. Field Offices: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading. Provide elevated walkway from parking area to field offices.
- B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, PM, Architect, and construction personnel office activities and to accommodate project meetings specified in other Division 01 Sections. Keep office clean and orderly.
 - 1. Provide elevated stabilized walkway from parking area to field offices.
 - 2. Furnish and equip offices as follows:
 - a. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
 - b. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no less 1 receptacle on each wall. Furnish room with conference table that will seat 10 attendees, chairs, and 4-foot-square track and marker boards.
 - c. Flex office for Architect's representative(s) and/or Owner representative including worktables with power and data.
 - d. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg. F.
 - e. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.
- C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations. Store combustible materials apart from building.

2.3 EQUIPMENT

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- B. Air Filtration Units: HEPA primary and secondary filter equipped portable units with four stage filtration. Provide single switch for emergency shut off. Configure to run continuously.
- C. Drinking Water: Containerized, tap dispenser, bottled water drinking water units, including paper cup supply. Where power is accessible, provide electric water coolers to maintain dispensed water temperatures at 45 degrees F to 55 degrees F (7.2 degrees C to 12.7 degrees C).
- D. Electrical Outlets: Properly configured, NEMA polarized outlets to prevent insertion of 110V to 120V plugs into higher voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
- E. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

- F. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid propane gas or fuel oil heaters with individual space thermostatic control.
 - 1. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.
 - 2. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of **8** at each return air grille in system and remove at end of construction. Clean HVAC system as required in Section 01 77 00 and install new filter with MERV 11 or greater.
- G. Air Filtration Units: Primary and secondary HEPA filter equipped with portable units with four stage filtrations. Provide single switch for emergency shut off. Configure to run continuously.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate facilities where they will serve project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
 - 1. Locate facilities to limit site disturbance as specified in Section 01 10 00.
- B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. Install temporary service. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
 - 1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.
- C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
 - 2. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
- E. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
- F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
 - 1. Prior to commencing Work, isolate the HVAC system in area where Work is to be performed according to coordination drawings.
 - a. Disconnect supply and return ductwork in Work area from HVAC systems servicing occupied areas.

- b. Maintain negative air pressure within Work area using HEPA equipped air filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
 - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust producing equipment. Isolate limited Work within occupied areas using portable dust containment devices.
 - 3. Perform daily construction cleanup and final cleanup using approved HEPA filter equipped with vacuum equipment.
- G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient conditions required and minimize energy consumption.
 - 1. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.
- H. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Install electric power service underground unless otherwise indicated.
 - 1. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.
 - a. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length voltage ratio.
 - b. Provide warning signs at power outlets other than 110 to 120 V.
 - c. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or traffic areas.
 - d. Provide metal conduit enclosures or boxes for wiring devices.
 - e. Provide 4 gang outlets, spaced so 100-foot (30 m) extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.
- I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 - 2. Install lighting for Project identification sign.
- J. Telephone Service: Provide temporary telephone service in common use facilities for use by construction personnel. Install one telephone line(s) for each field office.
 - 1. At each telephone, post a list of important telephone numbers.
 - a. Police and fire departments.
 - b. Ambulance service.
 - c. Contractor's home office.
 - d. Contractor's emergency after-hours telephone number.
 - e. Architect's office.
 - f. Engineers' offices.
 - g. Owner's office.
 - h. Principal subcontractors' field and home offices.
 - 2. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

- K. Electronic Communication Service: Provide a desktop computer and printer/scanner in the primary field office adequate for use by Architect and Owner to access Project electronic documents and maintain electronic communications.
1. Provide high speed wireless internet access (provide access to the Owner and Architect); DSL or broadband. Dial-up connection is not acceptable.
 2. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall.
 3. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.
 4. Backup: External hard drive, minimum 1 terabyte, with automated backup software providing daily backups.

3.3 SUPPORT FACILITIES INSTALLATION

- A. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines that is noncombustible according to ASTM E 136. Comply with NFPA 241.
1. Maintain support facilities until Architect schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- B. Temporary Use of Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
 2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00.
 3. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
 4. Delay installation of final course of permanent pavement until immediately before Substantial Completion.
- C. Traffic Controls: Comply with requirements of authorities having jurisdiction.
1. Protect existing site improvements to remain including curbs, pavement, and utilities.
 2. Maintain access for fire-fighting equipment and access to fire hydrants.
- D. Parking: Provide temporary parking areas for construction personnel.
- E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
- F. Waste Disposal Facilities: Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300.
- G. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.
1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and are not temporary facilities.
- H. Temporary Elevator Use: Use of elevators is not permitted.
- I. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

- J. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.4 SIGNS

- A. Furnish and install a project sign 6'-0" by 8'-0" (or 4'-0" x 8'-0" plywood) in size. Image will be provided to the graphics printing company by the Architect After Award of Contract. Contractor will be responsible for the cost of printing the image, mounting the sign on an aluminum substrate and installing the sign at the site. The sign will include the name of the project, District, name and title of Board of Trustees, District Superintendent, Contractor, Architect, and each of the project consultants.
- B. Other signs permitted at the site:
1. Warning signs.
 2. Directional signs.
 3. Identification signs at field offices.
 4. Emergency medical services sign.
 5. Signs required by Authorities Having Jurisdiction
 6. Storm Water Pollution Prevention Plan sign (SWPPP)
- C. Contractor shall allow no other signs to be displayed at the project site, unless authorized by the Owner.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities to the satisfaction of Owner and Architect.
- B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
- C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree or plant protection zones.
 2. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
 4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- D. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
- E. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
- F. Pest Control: Engage pest control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular

intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

- G. Site Enclosure Fence: Before construction operations begin. Provide site enclosure fences to prevent people and animals from easily entering site except by entrance gates.
 - 1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
- H. Security Enclosure and Lockup: Install temporary enclosures around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each Workday.
- I. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- J. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- K. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
 - 1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- L. Temporary Partitions: Provide floor to ceiling dustproof partitions to limit dust and dirt migration and to separate occupied areas occupied from fumes and noise.
 - 1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant treated plywood on construction operations side.
 - 2. Construct dustproof partitions with two layers of 6 mil (0.14 mm) polyethylene sheet on each side. Cover floor with two layers of 6 mil (0.14 mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire retardant treated plywood. Do not apply tape to finish floor surfaces.
 - a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water dampened foot mats in vestibule.
 - 3. Where fire resistance rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 - 4. Insulate partitions to control noise transmission to occupied areas.
 - 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 - 6. Protect air handling equipment.
 - 7. Provide walk off mats at each entrance through temporary partition.
- M. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - 1. Prohibit smoking in construction areas.
 - 2. Supervise welding operations, combustion type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 - 3. Develop and supervise an overall fire prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture Protection Plan: Avoid trapping water in finished Work. Document visible signs of mold that may appear during construction.
- B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
 1. Protect porous materials from water damage.
 2. Protect stored and installed material from flowing or standing water.
 3. Keep porous and organic materials from coming into prolonged contact with concrete.
 4. Remove standing water from decks.
 5. Keep deck openings covered or dammed.
- C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water-damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform Work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Condition Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use permanent HVAC system to control humidity.
 3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits and moisture control.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum based products, which become wet during the course of construction and remain wet for 48 hours are considered defective and are to be removed and replaced.
 - b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Architect.
 - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain facilities in good operating condition until removal.
 1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

- C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion unless otherwise required and approved by Owner and Architect.
- D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 01 77 00.

END OF SECTION 01 50 00

SECTION 01 55 26 TRAFFIC CONTROL

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work consists of furnishing traffic control devices and services for the control and protection of traffic through the area of construction in accordance with the Drawings and Specifications and in conformity with the details and at the locations shown on the approved plans for Temporary Traffic Control or as established by local ordinances and/or CalTrans Engineer.
- B. Safe Traffic Flow to and through the project site shall be maintained at all times.
- C. Traffic control shall conform to CalTrans's encroachment permit requirements or as designated by local ordinances.

1.3 SUBMITTALS

- A. Prior to beginning construction, the Contractor shall apply for any and all traffic related permits and/or encroachments required by CalTrans or local jurisdictions. Provide detailed plans, indicating direction and placement of traffic altering devices including advanced warning signage, detour signage required for the project. Temporary Traffic Control plan must be approved by the Architect, subjected to CalTrans permitting prior to beginning construction activities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

- A. There will be no interruption of traffic on adjacent and feeder roads to the residential and commercial usage by maintaining a minimum of one-way traffic.
- B. No construction shall begin until all traffic control signs and devices are installed by the Contractor.

END OF SECTION 01 55 26

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for selection of products, including but not limited to:
 - 1. Product delivery, storage, and handling.
 - 2. Manufacturers' written warranties on products.
 - 3. Special warranties.
 - 4. Comparable products.

1.3 DEFINITIONS

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term *product* includes the terms *material*, *equipment*, *system*, *assembly*, and terms of similar intent.
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature current as of date of the Contract Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis of Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words *basis of design product*, including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 SUBMITTALS

- A. Comparable Product Requests: Submit request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - 1. Include data to indicate compliance with the specified requirements.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Architect will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
 - a. Form of Approval: As specified in Section 01 33 00.

- b. Use product specified if Architect does not issue a decision on use of a comparable product request within time allocated.

- B. Basis of Design Product Specification Submittal: Comply with requirements in Section 01 33 00. Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
 - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
 - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
- B. Delivery and Handling:
 - 1. Schedule delivery to minimize long term storage at site and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- C. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger Project structure.
 - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 6. Protect stored products from damage and liquids from freezing.
 - 7. Provide a secure location and enclosure at site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
 - 1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
 - 2. Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

- B. Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
 - 1. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
 - 2. See other Sections for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Section 01 77 00.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

- A. Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
 - 1. Provide products complete with accessories, trim, finish, fasteners, and items needed for complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
 - 4. Where products are accompanied by the term "as selected", Architect will make selection.
 - 5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
 - 1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 3. Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 4. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
 - 5. Basis of Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and characteristics based on the product named. Comply with requirements for consideration of an unnamed product by one of the named manufacturers.
- C. Visual Matching Specification: Where Specifications require "*match Architect's sample*", provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether the proposed product matches.
 - 1. If no product available within specified category matches and complies with specified requirements, comply with requirements of Section 01 25 00 for proposal of product.

- D. Visual Selection Specification: Where Specifications include the phrase "*selected by Architect*" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product provides specified warranty.
 4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. Installation of the Work.
 - 4. Coordination of Owner-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.

1.3 DEFINITIONS

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair Work required to restore construction to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Certificates: Submit certificate signed by land surveyor or professional engineer certifying that location and elevation of improvements comply with requirements.
- B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.
- C. Certified Surveys: Submit two copies signed by land surveyor.
- D. Final Property Survey: Submit 10 copies showing the Work performed and record survey data.

1.5 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor legally qualified to practice in the State of Texas, who is experienced in providing land surveying services of the kind indicated.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with requirements specified in other Sections.

- B. In Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
 - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not warranted. Before beginning site Work, investigate and verify existence and location of underground utilities, mechanical and electrical systems, and construction affecting the Work.
 - 1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water service piping, underground electrical services, and other utilities.
 - 2. Furnish location data for Work related to the Work that must be performed by public utilities serving the site.
- B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, including the following:
 - 1. Description of the Work.
 - 2. List of detrimental conditions, including substrates.
 - 3. List of unacceptable installation tolerances.
 - 4. Recommended corrections.
- D. Proceed with installation after correcting unsatisfactory conditions. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to Owner necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 01 31 00.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly.
- B. Engage a land surveyor or professional engineer to lay out the Work using accepted surveying practices.
 - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as necessary to locate each element of Project.
 - 2. Establish limits on use of site.
 - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 - 4. Inform installers of lines and levels to which they must comply.
 - 5. Check the location, level and plumb, of every major element as the Work progresses.
 - 6. Notify Architect when deviations from required lines and levels exceed allowable tolerances.
 - 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.
- C. Site Improvements: Locate and layout site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.
- D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical Work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- E. Record Log: Maintain a log of layout control Work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Architect.

3.4 FIELD ENGINEERING

- A. Identification: Owner will identify existing benchmarks, control points, and property corners.
- B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
 - 1. Do not change or relocate existing benchmarks or control points without prior written approval of Architect. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Architect before proceeding.
 - 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
- C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
 2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
 3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.
- D. Certified Survey: On completion of foundation walls, major site improvements, and other Work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.
- E. Final Property Survey: Engage a land surveyor or professional engineer to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor or professional engineer, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.
1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
 2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical Work plumb and make horizontal Work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
 4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions to ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- G. Templates: Obtain and distribute to the parties' involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 2. Allow for building movement, including thermal expansion and contraction.
 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous. Materials containing asbestos and BCPs are prohibited.

3.6 OWNER INSTALLED PRODUCTS

- A. Site Access: Provide access to site for Owner's construction personnel.
- B. Coordination: Coordinate construction and operations of the Work with Work performed by Owner's construction personnel.
1. Construction Schedule: Inform Owner of Contractor's preferred construction schedule for Owner's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Owner if changes to schedule are required due to differences in actual construction progress.
 2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's Work. Attend pre-installation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.7 PROGRESS CLEANING

- A. Clean site and Work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 degrees F (27 degrees C).
 3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
 - a. Use containers intended for holding waste materials of type to be stored.
 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
- B. Site: Maintain site free of waste materials and debris.
- C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning

materials that are not hazardous to health or property and that will not damage exposed surfaces.

- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Coordinate startup and adjusting of equipment and operating components with mechanical, plumbing, and electrical requirements.
- B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 01 73 00

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Procedural requirements for cutting and patching.

1.3 DEFINITIONS

- A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair Work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

- A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
 - 2. Changes to In Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
 - 3. Products: List of products used for patching and firms or entities that will perform patching Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List of services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
 - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

1.5 QUALITY ASSURANCE

- A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.
- B. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
- C. Operational Elements: Do not cut and patch operating elements and related components that results in reducing the capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
 - 1. Primary operational systems and equipment.
 - 2. Fire separation assemblies.
 - 3. Air or smoke barriers.
 - 4. Fire suppression systems.

5. Mechanical systems piping and ducts.
 6. Control systems.
 7. Communication systems.
 8. Fire-detection and -alarm systems.
 9. Conveying systems.
 10. Electrical wiring systems.
 11. Operating systems of special construction.
- D. Miscellaneous Elements: Do not cut and patch the following elements or related components that change the load bearing capacity, resulting in a reduction of capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.
1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Exterior curtain wall construction.
 4. Equipment supports.
 5. Piping, ductwork, vessels, and equipment.
 6. Noise and vibration control elements and systems.
 7. Sprayed fire resistive material.
- E. Visual Requirements: Do not cut and patch construction resulting in visual evidence of cutting and patching. Do not cut and patch construction exposed to the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
1. If possible, retain original Installer or fabricator to cut and patch exposed Work. If possible, engage original Installer or fabricator. If original installer is not available, engage recognized, experienced, and specialized firm for the Work.
 - a. Processed concrete finishes.
 - b. Ornamental metal.
 - c. Matched veneer woodwork.
 - d. Preformed metal panels.
 - e. Roofing.
 - f. Firestopping.
 - g. Window system.
 - h. Fluid applied flooring.
 - i. Wall covering.
 - j. HVAC enclosures, cabinets, or covers.
- F. Cutting and Patching Conference: Before proceeding, meet at site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with specified requirements.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Services: Where removal, relocation, or abandonment is necessary, bypass existing services before cutting to avoid interruption of services to occupied areas.

3.3 CUTTING AND PATCHING

- A. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at earliest feasible time and complete without delay.
 1. Cut existing construction to provide for installation of components or performance of construction and subsequently patch as necessary to restore surfaces to an original condition.
 2. Cut in place construction to provide for installation of other components or performance of other construction and subsequently patch as required to restore surfaces to their original condition.
- B. Temporary Support: Provide temporary support for Work to be cut.
- C. Protection: Protect in place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- D. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 10 00.
- E. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 1. Use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

2. Finished Surfaces: Cut or drill from exposed or finished side into concealed surfaces.
 3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
 4. Excavating and Backfilling: Comply with requirements in applicable earthwork specifications by cutting and patching operations.
 5. Mechanical and Electrical Services: Cut off pipes or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portions of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 6. Proceed with patching after construction operations requiring cutting are complete.
- F. Patching: Patch construction by filling, repairing, refinishing, closing, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction to eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 3. Floors and Walls: Where walls or partitions are removed, extend one finished area into another, patch and repair surfaces in new space. Provide even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary to achieve uniform color and appearance.
 4. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 5. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
 6. Exterior Building Enclosure: Patch components and restore enclosure to a weathertight condition.

END OF SECTION 01 73 29

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PRE-CLOSEOUT MEETING

- A. Pre-Closeout Meeting: Schedule and convene Pre-Closeout Meeting with Owner and Architect in accordance with Section 01 31 00, Project Coordination and Management.

1.3 SUBSTANTIAL COMPLETION

- A. The items listed in Article 9 of the General Condition and Supplementary Conditions, and the following items shall be completed before Substantial Completion will be issued:
 - 1. Contractor's (Punch List): Submit a thorough list of items to be corrected, along with a written request for Substantial Completion and for review of the Work. The Architect/Engineer's Project Representative, at their discretion, may attend and assist in the preparation of the Contractor's Punch List.
 - 2. Architect's Supplemental Punch List: The Architect/Engineer, along with the Owner at the Owner's discretion, will inspect the Work utilizing the Contractor's prepared Punch List, noting completed items and incomplete items, and will prepare a supplemental list of items that have been omitted or incomplete items that were not previously noted.
 - 3. Operations and Maintenance Manuals: Submit as described in paragraph 1.3.
 - 4. Final Cleaning: Provide final cleaning and adequate protection of installed construction as described in paragraph 1.6 and 1.7.
 - 5. Starting of systems: Start up equipment and systems as described in paragraph 1.8.
 - 6. Testing and balancing: Testing and balancing of systems must be performed and completed and the report submitted and accepted by Architect/Engineer and Owner, as described in the Contract Documents. Make adjustments to equipment as required to achieve acceptance.
 - 7. Demonstrations: If required by individual specification sections or by Owner, provide demonstrations and instructions for use of equipment as described in paragraph 1.9.
- B. Date of Substantial Completion: Complete or correct items identified on Punch List and confirm that all items have been corrected prior to Architects re-inspection. Architect/Engineer, along with the Owner, will re-inspect the corrected work to establish the Date of Substantial Completion. Incomplete items remaining will be appended to the Certificate of Substantial Completion (AIA G704). The Date of Substantial Completion represents day one (1) of the closeout period and represents the date of commencement of the Contractors correctional period and all warranty periods as described and required by the Contract Documents, except as amended in the Certificate of Substantial Completion and elsewhere in the Contract Documents.
- C. Certificate of Substantial Completion: When the Work or designated portion thereof is substantially complete, Architect will prepare the Certificate of Substantial Completion to be executed by the Owner and Contractor. Items on the appended Punch List shall be completed or corrected within the time limits established in the Certificate.
- D. Within thirty (30) calendar days of substantial completion, contractor shall submit closeout submittals as required in accordance with this section.

1.4 PUNCH LIST

- A. A comprehensive list prepared by the Contractor prior to Substantial Completion, and attached thereto, to establish all items to be corrected, or very limited items of Work to be completed, if any. This list is intended to represent a limited number of items needing attention.
- B. Punch lists shall be furnished to the Architect in Microsoft Excel and PDF formats. The punch list shall be in matrix form and shall include the following information for each punch list item:
 - 1. Room number or other suitable location identifier
 - 2. Description of the work
 - 3. Sub-contractor/trade sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents
 - 4. Sub-contractor/trade sign-off date
 - 5. General contractor sign-off that the work has been verified to be 100% complete and in accordance with the Contract Documents
 - 6. General contractor/trade sign-off date
 - 7. A/E consultant sign-off
 - 8. A/E consultant sign-off date
 - 9. If requested by the Owner, provide two additional similar columns for their sign-off.
 - 10. In the case of excessive repetition of the same item at various locations, the punch list may contain "general notes/items" that shall be applied to the entire project; and it shall be the responsibility of the contractor/sub-contractor to thoroughly examine the entire project and make corrective measures at all applicable locations.
- C. Should the Architect determine that the Contractor's punch list lacks sufficient detail or requires extensive supplementation, the punch list will be returned to the Contractor for re-inspection and revision. The date of Substantial Completion will be delayed until the punch list submitted is a reasonable representation of the work to be done.
- D. A significantly large number of items to be completed or corrected will preclude the Architect from issuing a Certificate of Substantial Completion. The Owner and Architect will be the sole judge of what constitutes a significantly large number of items.
- E. The Contractor's superintendent shall participate in the preparation of the Contractor's punch list that is submitted to the Architect and Owner for supplementation. Upon receipt, the Architect and Consultants shall perform a spot review to determine the adequacy and completeness of the Contractor's punch list.
- F. Upon receipt of an acceptable Contractor's punch list, the Contractor's Superintendent shall accompany the Architect, his Consultants and the Owner (at his discretion) during their observation and the preparation of their supplements to the Contractor's punch list.
 - 1. The Superintendent shall record or otherwise take note of all supplementary items.
 - 2. The Architect will endeavor to furnish to the Contractor typed, hand written or recorded supplements to the punch list in a prompt manner; however, any delay in the Contractor's receiving said supplements from the Architect will not be cause for a claim for additional cost or extension of time as the Contractor's Superintendent shall have been in attendance during the inspections of the Architect and his Consultants and will have been expected to take his own notes.

1.5 OPERATIONS AND MAINTENANCE MANUAL

- A. As a requirement for Substantial Completion, the final Operation and Maintenance Manual shall be submitted to, and reviewed and accepted by the Architect prior to issuance of the Certificate.
- B. Prepare 3-ring D-slant binder cover and spline with printed title "OPERATIONS AND MAINTENANCE MANUAL", title of project, and subject matter of binder when multiple binders are required.
- C. Submit one (1) copy of preliminary Operations and Maintenance Manuals to respective consultants (Civil, MEP, Structural, etc.) for review of conformance with contract requirements prior to submitting final to Architect. Allow time for proper review.
- D. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- E. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- F. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and Maintenance, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Equipment start-up instructions
 - e. Operating instructions.
 - f. Maintenance instructions for equipment and systems.
 - g. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Product data.
 - b. Air and water balance reports.
 - c. Photocopies of warranties, certificates and bonds. Submit originals with Closeout Documents as specified below.
- G. Submit one (1) final original and two (2) copies to Architect. The final original will be delivered to the Owner.
- H. Contractor shall provide a flash drive, in PDF Format, the following documents after approval by the Architect, Consultants and Owner: closeout manual, MSDS binder, O&M Manuals, specifications and approved submittals. Documents shall be hyper-linked to the Table of Contents.

1.6 PROJECT CLOSEOUT PROCEDURES

- A. Final Payment will not be authorized by the Architect until the Architect finds the Work acceptable under the Contract Documents, subject to the completion and acceptance of the following requirements and other applicable Contract requirements:
 - 1. Close-out Documents: Provide bound closeout documents as described in paragraph 1.5. Refer to the Supplementary Conditions, Paragraph 9.10 for additional information.
 - 2. Record Documents: Submit as described in paragraph 1.10.

3. Extra materials: Provide extra stock, materials, and products as described in paragraph 1.11 when required by individual specification sections.
4. Locks: Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
5. Temporary Facilities: Discontinue and remove temporary facilities from the site, along with mockups, construction aids, and similar elements.
6. Warranties, Certificates and Bonds: Execute and assemble transferable warranty documents, certificates, and bonds from subcontractors, suppliers, and manufacturers as described in paragraph 1.12.
7. Final Inspection and Acceptance by Architect is achieved as described in paragraph 1.13.

1.7 CLOSEOUT DOCUMENTS

- A. Coordinate the following items with the requirements of Supplementary Conditions of the Contract.
- B. Prepare 3-ring D-slant binder cover and spline with printed title "CLOSEOUT DOCUMENTS", title of project, and subject matter of binder when multiple binders are required. Submit one (1) original and two (2) copies.
- C. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. The close-out documents shall be neatly organized and easily useable as determined by the Architect and Owner. Separate Close-out Documents binders from Operations and Maintenance Manuals. Documents identified as "affidavit" shall be notarized.
- E. Contents: Prepare Table of Contents for each volume, with each item description identified, typed on white paper, in five (5) parts as follows:
 1. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers. All General Contractor's vendors/suppliers and subcontractors that provided materials or performed any work related to this project must be listed on this form. Submit Final List of Subcontractors on Document AD.
 2. Part 2: Closeout Documents and Affidavits, include the following:
 - a. AIA G707 - Consent of Surety to Final Payment;
 - b. AIA G706 - Contractor's Affidavit of Payment of Debts and Claims;
 - c. AIA G706A - Contractor's Affidavit of Release of Liens;
 3. Part 3: Project documents and certificates, including the following:
 - a. Copy of Certificate of Substantial Completion (AIA G704);
 - b. Copy of All Permits;
 - c. Copy of Final Utility Bill or letter of transfer;
 - d. Copy of Certificate of Occupancy;
 - e. Copy of Certification of Project Compliance: Submit on attached **Close-out Form "B"**. Owner and Architect will initiate form and forward to Contractor for signature once Substantial Completion is established. (Owner to be provided original separately);
 4. Part 4: Warranties, Release of Liens, compile sequentially based on specification sections:
 - a. General Contractor's Warranty: Submit on company letterhead as described below. This Warranty shall state all sections of Work performed by General Contractor's own forces, and warranty period for each section of Work;

- b. Subcontractor's Release of Lien: Include contractor's, subcontractor's and direct material and equipment supplier's separate final releases. Submit on attached **Close-out Form "A"** – Subcontractor's Affidavit of Release of Lien.
 - c. Hazardous Material Certificate: Submit on attached **Close-out Form "C"**. Affidavits from Contractor, Subcontractors and General Contractor's vendors or suppliers stating that no hazardous materials/products have been used or installed in this project.
 - d. Subcontractor's Warranty: notarized, and submitted on attached **Close-out Form "D"**. This Warranty shall state all sections of Work performed by the subcontractor and warranty period.
 - e. Special / Extended Warranties; List and provide, notarized warranties requested by Owner, or required by or incorporated in the Contract Documents.
 - f. Spreadsheet depicting all items and materials that carry a warranty longer than one (1) year. Include information consisting of material/ supplier/ installer/ specification section/ length of warranty and contact information.
5. Part 5: Receipts:
- a. Extra Stock: Provide original receipts for delivery of "Extra Stock" items as described below. Receipts must be signed by an authorized Owner's representative;
 - b. Keys: Provide original receipts for delivery of "Keys". Receipts must be signed by an authorized Owner's representative.
 - c. Sign in sheets: provide signatures of attendees from all demonstrations.
- F. Failure to complete and close-out project after substantial completion may result in liquidated damages being assessed to the Contractor. Refer to Conditions of the Contract for additional requirements and liquidated damages.

1.8 FINAL CLEANING

- A. Execute final cleaning prior to final project inspection and acceptance.
- B. Clean interior and exterior glass, and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces, mop hard floor surfaces.
- C. Remove smudges, marks, stains, fingerprints, soil, dirt, spots, dust, lint, and other foreign materials from finished and exposed surfaces
- D. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
- E. Clean and replace filters of operating equipment as required by Contract Documents
- F. Clean debris from roofs, gutters, downspouts, and drainage systems.
- G. Clean site; sweep paved areas, rake clean landscaped surfaces.
- H. Remove waste and surplus materials, rubbish, and temporary construction facilities from site.

1.9 PROTECTING INSTALLED CONSTRUCTION

- A. Protect installed Work and provide special protection where specified in individual specification sections until Work is accepted by Architect and Owner.

- B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- F. Prohibit traffic from landscaped areas.

1.10 STARTING OF SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer and Owner 48 hours prior to start-up of each item.
- C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage. All demonstrations are to be documented by video and submitted to the Owner in flash drive format along with the close out documents. General contractor is responsible for all video and compilation onto flash drive with linked menus.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer.

1.12 PROJECT RECORD DOCUMENTS

- E. Verify wiring and support components for equipment are complete and tested.
 - F. Execute start-up under supervision of Contractors' personnel and installer in accordance with manufacturers' instructions.
 - G. When specified in individual specification sections or required by manufacturer, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
 - H. When specified in individual specification sections or required by Owner or Architect/Engineer, submit a written report in accordance with Section 01 33 00 - Submittal Procedures, that equipment or system has been properly installed and is functioning correctly.
- 1.11 DEMONSTRATION AND INSTRUCTIONS
- A. Demonstrate operation and maintenance of products to Owner's personnel a minimum of 48 hours prior to date of Final Completion in accordance with Owner's requirements.
 - B. Demonstrate Project equipment instructed by qualified manufacturer's representative who is knowledgeable about the Project and equipment.
 - C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six (6) months.
 - D. Utilize maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel to explain all aspects of operation and maintenance.

- E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment.
- F. Prepare and insert additional data in maintenance manuals when need for additional data becomes apparent during instruction.
- G. Review and verify proper start-up and operation of equipment prior to scheduling demonstrations with Owner.
- H. All demonstrations are to be documented by video and submitted to the Owner in flash drive format along with the close out documents. General contractor is responsible for all video and compilation onto flash drive with linked menus.

1.12 PROJECT RECORD DOCUMENTS

- A. Project Record Documents, as described in Section 01 78 39, shall be submitted at Project Closeout. Final Payment will not be authorized by the Architect until final review and acceptance by Architect and Engineers is achieved in accordance with the Owners requirements.
- B. Submit reproducible to respective consultants (Civil, Structural, MEP, *etc.*) for review. Consultant will mark-up corrections and return to Contractor for final revisions. Make final revisions prior to submitting to Architect.
 - 1. Format: One (1) set of film positive reproducible and two (2) sets blueines of approved reproducible.
 - 2. Provide the Owner with one (1) set of Record Drawings on a non-rewritable flash drive in AutoCAD® latest release or BIM files per Owner's request.
 - 3. Provide the Owner with one (1) set of Record Drawings on a on a non-rewritable flash drive in PDF format.
 - 4. Label electronic BIM files and PDF files in the same manner as the sheets (example, A2.02 First Floor Area 'A', *etc.*)
 - 5. Format: Submit all Project Record Documents as a bookmarked, indexed, searchable, annotated electronic PDF file.

1.13 EXTRA STOCK, MATERIALS AND MAINTENANCE PRODUCTS

- A. Furnish extra stock, maintenance, and extra products in quantities specified in individual specification sections.
- B. Deliver to Project site or to District Maintenance Department as directed by Owner; obtain signed receipt from Owner's authorized representative prior to final application for payment. Delivery of materials to, or obtaining receipt from anyone other than Owner's authorized representative may constitute breach of this requirement and may require delivery of additional materials at no cost to the Owner if original materials are misplaced.
- C. Include signed receipts for delivery of extra stock and materials, including keys, with Closeout Documents.

1.14 WARRANTIES, CERTIFICATES AND BONDS

- A. Definitions:
 - 1. Standard Product Warranties: preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.

2. Special Warranties: written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide coverage of specific defects, or both.
- B. In accordance with the general warranty obligations under Paragraph 3.5 of the General Conditions as amended by the Supplementary Conditions, the General Contractor's warranty shall be for a period of one (1) year following the date of Substantial Completion, hereinafter called the one-year warranty period. The Contractor's one-year general warranty shall include all labor, material and delivery costs required to correct defective material and installation. This warranty shall not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.
- C. The Contractor's one-year warranty shall run concurrently with the one (1) year period for correction of Work required under Paragraph 12.2 of the General Conditions.
- D. No service charges or call out charges are allowed to investigate warranty claims.
- E. In addition to the Contractor's one-year warranty, Special Warranties as described in individual specifications sections, shall extend the warranty period for the period specified without limitation in respect to other obligations which the Contractor has under the Contract Documents.
- F. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve the suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- G. Warranty Requirements:
 1. When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
 2. When Work covered by a warranty has failed and been corrected by replacement or reconstruction, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
 3. Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
 4. Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, rights and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
 5. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or designated portion of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- H. Compile copies of each required warranty properly executed by the Contractor and the subcontractor, supplier, or manufacturer. Verify documents are in proper form, contain full information, and are notarized. Co-execute warranties, certificates and bonds when required and include signed warranties with Closeout Documents submitted to the Architect.

1.15 FINAL COMPLETION AND FINAL PAYMENT

- A. Final Notice and Inspection:

1. When all items on the Punch List have been corrected, final cleaning has been completed, and installed work has been protected, submit written notice to the Architect that the Work is ready for final inspection and acceptance.
 2. Upon receipt of written notice that the Work is ready for final inspection and acceptance, the Architect and Engineer will make final inspection.
- B. Final Change Order: When the Project Closeout items described above are successfully completed and the Work is found acceptable to Architect/Engineer and Owner, a Final Change Order will be executed. This Change Order will include any Allowance adjustments as required by the Contract Documents.
- C. Final Application for Payment: When all of the above items are successfully complete, submit to the Architect a final Application for Payment and request for release of retainage.
- D. Release of Retainage: Release of retainage will not be authorized by the Architect until Contractor completes all requirements for close-out to the satisfaction of the Owner and Architect as described herein.

1.16 TERMINAL INSPECTION

- A. Immediately prior to expiration of the one (1) year period for correction of the Work, the Contractor shall make an inspection of the work in the company of the Architect and the Owner. The Architect and the Owner shall be given not less than ten (10) days notice prior to the anticipated date of terminal inspection.
- B. Where any portion of the work has proven to be defective and requires replacement, repair or adjustment, the Contractor shall immediately provide materials and labor necessary to remedy such defective work and shall execute such work without delay until completed to the satisfaction of the Architect and the Owner, even if the date of completion of the corrective work may extend beyond the expiration date of the correction period.
- C. The Contractor shall not be responsible for correction of work which has been damaged because of neglect or abuse by the Owner nor the replacement of parts necessitated by normal wear in use.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

PART 4 – SCHEDULE

Item	Date of Issue
Schedule of Closeout Conference	180 days before Substantial Completion
Operations & Maintenance Manuals	60 Days before Substantial Completion
Contractor's Punch List	Include with formal request for Substantial Completion.
As-Builts	With Substantial Completion
Affidavits	30 Days after Substantial Completion
Release of Liens	60 Days after Substantial Completion
Testing and Balance Report	With Substantial Completion
Warranty Forms	60 Days after Substantial Completion

END OF SECTION 01 77 00

SECTION 01 77 01 CLOSEOUT FORMS

CLOSE-OUT FORM "A"

SUBCONTRACTOR'S AFFIDAVIT OF RELEASE OF LIEN

STATE OF _____

COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says:

1. That he / she is the _____ of _____, the subcontractor who supplied, installed, and /or erected the work described below, and that, he /she is duly authorized to make this Affidavit and Subcontractor Release:

Project: Cunningham Middle School and North Shore Middle School

Owner: Galena Park Independent School District

Architect: BEAM

Work Performed: _____ Specification Section(s): _____

2. That all work required under the subject subcontractor of the subject construction project has been performed in accordance with the terms thereof, that all material men, sub-subcontractors, mechanics, and laborers have been paid and satisfied in full and that there are no outstanding claims of any character arising out of the performance of said subcontractor which have not been paid and satisfied in full.
3. That to the best of his / her knowledge and belief, there are no unsatisfied claims for damages resulting from injury or death to any employees, sub-subcontractors, or the public at large arising out of the performance of said subcontract, or any suits or claims for any other damages of any kind, nature, or description which might constitute a lien upon the property of the Owner.
4. That he / she has received full payment of all sums due him / her for materials furnished and services rendered by the undersigned in connection with the performance of said subcontract and has and does hereby release the Owner and the Architect and his consultants and the Contractor from any and all claims of any character arising out of or in any way connected with performance of said subcontract.

ATTEST (If Corporation)

Name of Subcontractor

Secretary

(By)

(Title)

JURAT

STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me on this _____ day of _____, 20____.

(Seal)

(Notary Public Signature)

CLOSE OUT FORM "B"

**CERTIFICATION
OF PROJECT
COMPLIANCE**

Completion of this form is required under the provisions of §61.1040 19 TAC for all public school district construction projects. Instructions for completion of this form can be found on page 2.

1. PROJECT INFORMATION

Facility:

Address:

City:

DISTRICT:

ARCHITECT/ENGINEER:

CONTRACTOR/CM:

CONTRACT DATE:

DATE DISTRICT AUTHORIZED PROJECT:

BRIEF DESCRIPTION OF PROJECT:

2. CERTIFICATION OF DESIGN AND CONSTRUCTION

The intent of this document is to assure that the school district has provided to the architect/engineer the required information and the architect/engineer has reviewed the School Facilities Standards as required by the State of Texas, and used his/her reasonable professional judgment and care in the architectural/engineering design and that the contractor has constructed the project in a quality manner in general conformance with the design requirements and that the school district certifies to project completion.

3. The District certifies that the educational program and the educational specifications of this facility along with the identified building code to be used have been provided to the architect/engineer.

DISTRICT:

BY:

DATE:

4. The Architect/Engineer certifies the above information was received from the school district, and that the building(s) were designed in accordance with the applicable building codes. Further, the facility has been designed to meet or exceed the design criteria relating to space (minimum square footage), educational adequacy, and construction quality as contained in the School Facilities Standards as adopted by the Commissioner of Education, June 9, 2003, and as provided by the district.

ARCHITECT/ENGINEER:

BY:

DATE:

5. The Contractor/CM certifies that this project has been constructed in general conformance with the construction documents as prepared by the architect/engineer listed above.

CONTRACTOR/CM:

BY:

DATE:

6. The District certifies completion of the project (as defined by the architect/engineer and contractor).

DISTRICT:

BY:

DATE:

INSTRUCTIONS FOR COMPLETION OF "CERTIFICATION OF PROJECT COMPLIANCE" FORM

Section 1. Identify the following:

- name and address of the school facility
- name of the school district
- the Architect/Engineer and Contractor
- the date of execution of the construction contract
- the date that the school district authorized the superintendent to hire an architect/engineer
- scope of the project.

Section 2. This section outlines the intent of the document. No action required.

Section 3. This section is to be executed by the school district upon transmittal of the information (as listed) to the architect/engineer and is to remain in the custody of the school district throughout the entire project.

Section 4. This section is to be executed by the architect/engineer upon completion of the plans and specifications and in conjunction with the completion of the plan review for code compliance (ref. 19 TAC §61.1040, School Facilities Standards) and returned to the school district's files.

Section 5. This section is to be executed by the contractor upon substantial completion of the project and retained in the school district's files.

Section 6. This section is to be executed by the school district upon acceptance and occupancy of the project.

NOTE: DO NOT SUBMIT THIS DOCUMENT TO THE TEXAS EDUCATION AGENCY. The school district will retain this document in their files indefinitely until review and/or submittal is required by representatives of the Texas Education Agency.

CLOSE-OUT FORM "C"

SUBCONTRACTOR HAZARDOUS MATERIAL CERTIFICATE

THE STATE OF _____ PROJECT: Cunningham Middle School and North Shore Middle School

COUNTY OF _____ OWNER: Galena Park Independent School District

ARCHITECT: BEAM

SPECIFICATION SECTION(S):

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says that he / she is the

_____ of _____, the subcontractor / supplier who constructed or provided the section(s) of work referenced above, and that he / she is duly authorized to certify to the best of his / her information, knowledge, and belief no asbestos, lead or PCB containing products have been incorporated into the project.

ATTEST (If Corporation)

Name of Subcontractor / Supplier

(Title)

Secretary (By)

JURAT

THE STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me on this _____ day of _____, 20____.

(Seal)

(Notary Public Signature)

CLOSE-OUT FORM "D"

SUBCONTRACTOR WARRANTY

STATE OF _____

COUNTY OF _____

KNOW ALL MEN BY THESE PRESENTS:

_____, being first duly sworn, deposes and says:

1. That he / she is the Subcontractor (or the _____ of _____ the subcontractor) who supplied, installed, and / or erected the work described below, and that, he / she is duly authorized to make this Subcontractor Warranty:

Project: Cunningham Middle School and North Shore Middle School

Owner: Galena Park Independent School District Architect: BEAM

Work Performed: _____ Specification Section(s): _____

2. The undersigned Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract are of good quality and new except where otherwise required or permitted by the Contract Documents, that the Work is free from defects not inherent in the quality required or permitted, and that the Work conforms with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. The Subcontractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Subcontractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.
3. In the event of failure of materials, products, or workmanship, during the specified warranty periods, the Subcontractor shall take appropriate measures to assure correction or replacement of the defective items, whether notified by the Contractor, Owner or Architect.
4. The Subcontractor warrants the work performed for a period of _____ months from the date of Substantial Completion, except as follows: _____

ATTEST (If Corporation)

Name of Subcontractor

Secretary

(By)

(Title)

JURAT

STATE OF _____

COUNTY OF _____

BEAM Professionals
Project No. 250373
Issue For Proposal

Cunningham Middle School and North Shore Middle School
Galena Park Independent School District
December 05, 2025

Sworn to and subscribed before me on this _____ day of _____, 20____.

(Seal)

(Notary Public Signature)

SECTION 01 77 02 - WAIVER AND RELEASE OF LIENS

PART 1 GENERAL

1.1 SUMMARY

- A. Document Includes: Applicability and use of statutory Waiver and Release of Lien forms promulgated by the Legislature of the State of Texas for construction projects in Texas.
- B. Related Requirements:
 - 1. The Contract for Construction (also referred to as the Agreement or the Contract)
 - 2. Conditions of the Contract (General, Supplementary, and other conditions, if any)
 - 3. Section 01 29 00 Payment Procedures
 - 4. Section 01 77 00 Contract Closeout
 - 5. Section 01 77 01 Closeout Procedures

1.2 REFERENCES

- A. Texas Property Code, Chapter 53, Subchapter L, Sections 53.281 thru 53.287 (includes the standard forms attached herewith immediately following this section):
 - 1. Form 1: Conditional Waiver for Progress Payments
 - 2. Form 2: Unconditional Waiver for Progress Payments
 - 3. Form 3: Conditional Waiver for Final Payments
 - 4. Form 4: Unconditional Waiver for Final Payments

PART 2 PRODUCTS *(not used)*

PART 3 EXECUTION

3.1 SELECTION AND USE OF WAIVER AND RELEASE OF LIEN FORMS

- A. Based on answers to the following questions, use the applicable form for the occasion:
 - 1. Is the payment a *progress* payment (partial, not final), or a *final* payment?
 - 2. Is the release *unconditional* (for a payment already received), or *conditional* (given in anticipation of a payment not yet received)?
- B. Submit the applicable form, properly executed (filled out, signed and dated) and notarized, on each occasion required (see other portions of the Contract Documents, including but not necessarily limited to the related requirements documents cited above).
- C. The wording of these forms is prescribed by the State of Texas. Questions regarding their use, execution, etc. should be directed to user's own attorney experienced in construction or lien law. This document is not to be interpreted as rendering legal advice.
- D. Even if the Contract Documents do not explicitly require submittal of Waivers and Releases of Liens for every payment (for example, omitting them for monthly progress payments), the Owner reserves the right, at its sole discretion, to require applicable Waivers and Releases of Liens, executed and notarized, for any or all payments.

END OF DOCUMENT A1
(see following pages for standard forms)

FORM 1: CONDITIONAL WAIVER FOR PROGRESS PAYMENTS

PROJECT NAME: _____
OWNER'S NAME: _____ PROJECT NUMBER _____

CONDITIONAL WAIVER AND RELEASE ON PROGRESS PAYMENT

On receipt by the signer of this document of a check from _____ (maker of check) in the sum of \$ _____ payable to _____ (payee or payees of check) and when the check has been properly endorsed and has been paid by the bank on which it is drawn, this document becomes effective to release any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the property of _____ (owner) located at _____ (location) to the following extent:
_____ (job description).

This release covers a progress payment for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) as indicated in the attached statement(s) or progress payment request(s), except for unpaid retention, pending modifications and changes, or other items furnished.

Before any recipient of this document relies on this document, the recipient should verify evidence of payment to the signer.

The signer warrants that the signer has already paid or will use the funds received from this progress payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____
_____ (Company name)
By _____ (Signature)
_____ (Printed/Typed name)
_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This _____ day of _____, 20____ A.D.

Notary Public in and for the state of _____

FORM 2: UNCONDITIONAL WAIVER FOR PROGRESS PAYMENTS

PROJECT NAME: _____

OWNER'S NAME: _____ PROJECT NUMBER _____

NOTICE: THIS DOCUMENT WAIVES RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. IT IS PROHIBITED FOR A PERSON TO REQUIRE YOU TO SIGN THIS DOCUMENT IF YOU HAVE NOT BEEN PAID THE PAYMENT AMOUNT SET FORTH BELOW. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL RELEASE FORM.

UNCONDITIONAL WAIVER AND RELEASE ON PROGRESS PAYMENT

The signer of this document has been paid and has received a progress payment in the sum of \$_____ for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) on the property of _____ (Owner) located at _____ (location) to the following extent: _____ (job description). The signer therefore waives and releases any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the above referenced project to the following extent:

This release covers a progress payment for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) as indicated in the attached statement(s) or progress payment request(s), except for unpaid retention, pending modifications and changes, or other items furnished.

The signer warrants that the signer has already paid or will use the funds received from this progress payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____

_____ (Company name)

By _____ (Signature)

_____ (Printed/Typed name)

_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

FORM 3: CONDITIONAL WAIVER FOR FINAL PAYMENTS

PROJECT NAME: _____
OWNER'S NAME: _____ PROJECT NUMBER _____

CONDITIONAL WAIVER AND RELEASE ON FINAL PAYMENT

Project _____

Job. No. _____

On receipt by the signer of this document of a check from _____ (maker of check) in the sum of \$_____ payable to _____ (payee or payees of check) and when the check has been properly endorsed and has been paid by the bank on which it is drawn, this document becomes effective to release any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position that the signer has on the property of _____ (owner) located at _____ (location) to the following extent:
_____ (job description).

This release covers the final payment to the signer for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted).

Before any recipient of this document relies on this document, the recipient should verify evidence of payment to the signer.

The signer warrants that the signer has already paid or will use the funds received from this final payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project up to the date of this waiver and release.

Date _____
_____ (Company name)
By _____ (Signature)
_____ (Printed/Typed name)
_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

FORM 4: UNCONDITIONAL WAIVER FOR FINAL PAYMENTS

PROJECT NAME: _____
OWNER'S NAME: _____ PROJECT NUMBER _____

NOTICE: THIS DOCUMENT WAIVES RIGHTS UNCONDITIONALLY AND STATES THAT YOU HAVE BEEN PAID FOR GIVING UP THOSE RIGHTS. IT IS PROHIBITED FOR A PERSON TO REQUIRE YOU TO SIGN THIS DOCUMENT IF YOU HAVE NOT BEEN PAID THE PAYMENT AMOUNT SET FORTH BELOW. IF YOU HAVE NOT BEEN PAID, USE A CONDITIONAL RELEASE FORM.

UNCONDITIONAL WAIVER AND RELEASE ON FINAL PAYMENT

Project _____

Job. No. _____

The signer of this document has been paid in full for all labor, services, equipment, or materials furnished to the property or to _____ (person with whom signer contracted) on the property of _____ (owner) located at _____ (location) to the following extent: _____ (job description). The signer therefore waives and releases any mechanic's lien right, any right arising from a payment bond that complies with a state or federal statute, any common law payment bond right, any claim for payment, and any rights under any similar ordinance, rule, or statute related to claim or payment rights for persons in the signer's position.

The signer warrants that the signer has already paid or will use the funds received from this final payment to promptly pay in full all of the signer's laborers, subcontractors, materialmen, and suppliers for all work, materials, equipment, or services provided for or to the above referenced project in regard to the attached statement(s) or progress payment request(s).

Date _____
_____ (Company name)
By _____ (Signature)
_____ (Printed/Typed name)
_____ (Title)

SWORN AND SUBSCRIBED before me at _____, _____, This ____ day of _____.
20____ A.D.

Notary Public in and for the state of _____

BEAM Professionals
Project No. 250373
Issue For Proposal

Cunningham Middle School and North Shore Middle School
Galena Park Independent School District
December 05, 2025

(END OF ATTACHED FORMS)

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and maintenance documentation directory manuals.
 - 2. Emergency manuals.
 - 3. Systems and equipment operation manuals.
 - 4. Systems and equipment maintenance manuals.
 - 5. Product maintenance manuals.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.
 - 1. Architect will comment on whether content of operation and maintenance submittals is acceptable.
 - 2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.
- B. Format: Submit operation and maintenance manuals in the following format:
 - 1. Submit on digital media acceptable to Architect or by uploading to web-based project software site or by email to Architect. Enable reviewer comments on draft submittals.
 - 2. Submit three paper copies. Architect, will return two copies.
- C. Initial Manual Submittal: Submit draft copy of each manual at least 30 days before commencing demonstration and training. Architect will comment on whether general scope and content of manual are acceptable.
- D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Architect will return copy with comments.
 - 1. Correct or revise each manual to comply with Architect's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Architect's comments and prior to commencing demonstration and training.
- E. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.5 FORMAT OF OPERATION AND MAINTENANCE MANUALS

- A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.
 - 1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.
 - 2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- B. Manuals, Paper Copy: Submit manuals in the form of hard-copy, bound and labeled volumes.
 - 1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
 - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. Indicate volume number for multiple-volume sets.
 - 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
 - 3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
 - 4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
 - 5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.6 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

- A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Include the following information:

1. Subject matter included in manual.
 2. Name and address of Project.
 3. Name and address of Owner.
 4. Date of submittal.
 5. Name and contact information for Contractor.
 6. Name and contact information for Construction Manager.
 7. Name and contact information for Architect.
 8. Name and contact information for Commissioning Authority.
 9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
 10. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.7 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:
1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
 2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
 3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.8 EMERGENCY MANUALS

- A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- B. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Power failure.
 6. Water outage.
 7. System, subsystem, or equipment failure.
 8. Chemical release or spill.
- D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- E. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.

1.9 SYSTEMS AND EQUIPMENT OPERATION MANUALS

- A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.
1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:
1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
 2. Performance and design criteria if Contractor has delegated design responsibility.
 3. Operating standards.
 4. Operating procedures.
 5. Operating logs.
 6. Wiring diagrams.
 7. Control diagrams.
 8. Piped system diagrams.
 9. Precautions against improper use.
 10. License requirements including inspection and renewal dates.
- C. Descriptions: Include the following:
1. Product name and model number. Use designations for products indicated on Contract Documents.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.

- D. Operating Procedures: Include the following, as applicable:
 - 1. Startup procedures.
 - 2. Equipment or system break-in procedures.
 - 3. Routine and normal operating instructions.
 - 4. Regulation and control procedures.
 - 5. Instructions on stopping.
 - 6. Normal shutdown instructions.
 - 7. Seasonal and weekend operating instructions.
 - 8. Required sequences for electric or electronic systems.
 - 9. Special operating instructions and procedures.
- E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- F. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

1.10 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

- A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.
- C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:
 - 1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
 - a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
 - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 - 3. Identification and nomenclature of parts and components.
 - 4. List of items recommended to be stocked as spare parts.

- E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Test and inspection instructions.
 - 2. Troubleshooting guide.
 - 3. Precautions against improper maintenance.
 - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - 5. Aligning, adjusting, and checking instructions.
 - 6. Demonstration and training video recording, if available.
- F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
 - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
 - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
- J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.
 - 1. Do not use original project record documents as part of maintenance manuals.

1.11 PRODUCT MAINTENANCE MANUALS

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.
- D. Product Information: Include the following, as applicable:
 - 1. Product name and model number.
 - 2. Manufacturer's name.
 - 3. Color, pattern, and texture.
 - 4. Material and chemical composition.
 - 5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Administrative and procedural requirements for project record documents, including but not limited to:
 - 1. Record Drawings.
 - 2. Record Specifications.
 - 3. Record Product Data.
 - 4. Miscellaneous record submittals.

1.3 CLOSEOUT SUBMITTALS

- A. Record Drawings:
 - 1. Number of Copies: Submit one set of marked up record prints.
 - 2. Number of Copies: Submit copies of record Drawings:
 - a. Initial Submittal:
 - 1) Submit PDF electronic files of scanned record prints and one of file prints.
 - 2) Submit record digital data files and one sets of plots.
 - 3) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.
 - b. Final Submittal:
 - 1) Submit PDF electronic files of scanned record prints and three sets of prints.
 - 2) Submit record digital data files and three sets of record digital data file plots.
 - 3) Plot each drawing file, whether or not changes and additional information were recorded.
- B. Record Specifications: Submit one paper copy and one annotated PDF electronic file of the Project Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one paper copy and one annotated PDF electronic file and directory of each submittal.
 - 1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked up Product Data as a component of manual.
- D. Miscellaneous Record Submittals: Refer to the individual Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Submit one paper copy and annotated PDF electronic files and directories of each submittal.
- E. Reports: Submit written report monthly indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 PROJECT RECORD DOCUMENT PROCEDURES

- A. Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference.

1. Do not use As Built Drawings and Specifications for Record Drawings and Specifications.
- B. Recording Procedures: Update drawings and specifications on daily bases to record actual conditions. Record information concurrently with construction progress. Do not conceal Work until required information is accurately recorded.
- C. Store Record Documents and samples apart from as built documents used for construction.
 1. Label and file Record Documents and samples in accordance with section number listings in Table of Contents. Label each document *PROJECT RECORD* in neat, large, printed letters.
 2. Maintain Record Documents in clean, dry and legible condition.
 3. Make Record Documents and samples available for inspection upon request of Architect.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: Maintain one set of marked paper copies of the Contract Drawings and Shop Drawings.
 1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked up record prints. Show actual installation conditions where installation varies from that shown originally.
 - a. Give attention to information on concealed elements difficult to identify or measure and record later.
 - b. Accurately record information in an acceptable drawing technique.
 - c. Record data as soon as possible after obtaining it.
 - d. Record and check the markup before enclosing concealed installations.
 - e. Cross reference record prints corresponding shop drawings or archive photographic documentation.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Dimensional changes to Drawings.
 - b. Revisions to details shown on Drawings.
 - c. Depths of foundations below first floor.
 - d. Locations and depths of underground utilities.
 - e. Revisions to routing of piping and conduits.
 - f. Revisions to electrical circuitry.
 - g. Actual equipment locations.
 - h. Duct size and routing.
 - i. Locations of concealed internal utilities.
 - j. Changes made by Change Order or Construction Change Directive.
 - k. Changes made following Architect's written orders.
 - l. Details not on the original Contract Drawings.
 - m. Field records for variable and concealed conditions.
 - n. Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked up record prints.
 4. Mark record sets with erasable, red colored pencil. Use colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked up record prints with Architect. When authorized, prepare full set of corrected digital data files for the Contract Drawings:
 1. Format: Same digital data software program, version, and operating system as the original Contract Drawings and annotated PDF electronic file with comment function enabled.
 2. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
 3. Refer instances of uncertainty to Architect for resolution.
 4. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.
 - a. Refer to Section 01 33 00 for requirements related to use of Architect's digital data files.
 - b. Architect will provide data file layer information. Record markups in separate layers.
- C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.
 1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or modification.
 2. Consult Architect for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.
- D. Format: Identify and date each record Drawing; include the designation *PROJECT RECORD DRAWING* in a prominent location.
 1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
 2. Format: Annotated PDF electronic file with comment function enabled.
 3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
 4. Identification as follows:
 - a. Project name.
 - b. Date.
 - c. Designation PROJECT RECORD DRAWINGS.
 - d. Name of Architect.
 - e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications. Indicate actual product installation where installation varies from that indicated in Specifications.
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.

3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
 5. Note related Change Orders, record Product Data, and record Drawings where applicable.
- B. Format: Submit record Specifications as annotated PDF electronic file and marked up paper copy of Specifications.

2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.
1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to Project site and changes in manufacturers' written instructions for installation.
 3. Note related Change Orders, record Specifications, and record Drawings where applicable.
- B. Format: Submit record Product Data as annotated PDF electronic file. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 RECORD SAMPLES

- A. Record Samples: Determine with Architect and Owner which submitted Samples are to be maintained as Record Samples. Maintain and mark one set to indicate date of review and approval by Architect; note any deviations or variations between reviewed sample and installed product or material.

2.5 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by the individual Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Include the following:
1. Reviewed shop drawings, product data, and samples.
 2. Field test reports.
 3. Inspection certificates and manufacturer's certificates.
 4. Inspections by authorities having jurisdiction (AHJ).
 5. Documentation of foundation depths.
 6. Special measurements or adjustments.
 7. Tests and inspections.
 8. Surveys.
 9. Design mixes.
- B. Format: Submit miscellaneous record submittals as scanned PDF electronic file(s) of marked up miscellaneous record submittals. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.
- B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Demonstration and training video recordings.
 - 4. O&M Manuals should be uploaded into Owner's designated software (Prolog)

1.3 INFORMATIONAL SUBMITTALS

- A. Instruction Program: Submit outline of instructional program for demonstration and training including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 1. Indicate proposed training modules utilizing manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
- B. Qualification Data: For instructor.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.

1.4 CLOSEOUT SUBMITTALS

- A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
 - 1. Identification: On each copy, provide an applied label with the following information:
 - a. Name of Project.
 - b. Name and address of videographer.
 - c. Name of Architect.
 - d. Name of Contractor.
 - e. Date of video recording.
 - 2. At completion of training, submit complete training manual(s) for Owner's use.

1.5 QUALITY ASSURANCE

- A. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.

1.6 COORDINATION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project record documents.
 - e. Identification systems.
 - f. Warranties and bonds.
 - g. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.

- b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Division 01 Section "Operations and Maintenance Data."
- B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Owner will furnish an instructor to describe Owner's operational philosophy.
 - 2. Owner will furnish Contractor with names and positions of participants.

- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
 - 1. Schedule training with Owner through Program Manager with at least 10 days' advance notice.
- C. Cleanup: Collect used and leftover educational materials and give to Owner. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
- B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Architect.
- C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

END OF SECTION 01 79 00

Project Manual

for

Cunningham Middle School and North Shore Middle School

BEAM Project No.: 250373

Galena Park Project No.: B108

for the

GALENA PARK INDEPENDENT SCHOOL DISTRICT

December 05, 2025

Issue for Proposal

Volume 2

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SECTION 02 41 00 - DEMOLITION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the General Conditions, Supplementary Conditions, Drawings, Specifications, and the Sections included under Division 01 General Requirements and References, are included as a part of this Section as though bound herein.

1.2 SUMMARY

- A. Section Includes:
 - 1. Furnishing all labor, materials, and equipment necessary for demolition, dismantling, cutting, and alterations as indicated, specified, and required for completion of the Contract, as applicable. Includes items such as the following:
 - a. Salvage of building elements for reuse, return to the Owner, or sale.
 - b. Building demolition excluding removal of hazardous materials and toxic substances.
 - c. Selective demolition of built site elements.
 - d. Selective demolition of building elements for alteration purposes.
 - e. Abandonment and removal of existing utilities and utility structures.
 - f. Protection of existing work to remain.

1.3 RELATED REQUIREMENTS

- A. Section 00 31 00 - Available Project Information: Existing building survey conducted by Owner; information about known hazardous materials.
- B. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
- C. Section 01 10 00 - Summary: Sequencing and staging requirements.
- D. Section 01 10 00 - Summary: Description of items to be removed by Owner.
- E. Section 01 10 00 - Summary: Description of items to be salvaged or removed for re-use by Contractor.
- F. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- G. Section 01 57 13 - Temporary Erosion and Sediment Control.
- H. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- I. Section 01 73 00 - Execution: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.
- J. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
- K. Section 31 10 00 - Site Clearing: Vegetation and existing debris removal.
- L. Section 31 22 13 - Rough Grading: Topsoil removal.
- M. Section 31 22 13 - Rough Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
- N. Section 31 23 23 - Fill: Fill material for filling holes, pits, and excavations generated as a result of removal operations.
- O. Section 31 23 23 - Fill: Filling holes, pits, and excavations generated as a result of removal operations.
- P. Section 32 93 00 - Plants: Relocation of existing trees, shrubs, and other plants.
- Q. Section 32 93 00 - Plants: Pruning of existing trees to remain.

1.4 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.5 SUBMITTALS

- A. Refer to Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Vegetation to be protected.
 - 2. Areas for temporary construction and field offices.
 - 3. Areas for temporary and permanent placement of removed materials.
- C. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.
 - 1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.
 - 2. Identify demolition firm and submit qualifications.
 - 3. Include a summary of safety procedures.
- D. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.6 EXISTING CONDITIONS

- A. The Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during work, notify Architect promptly for instructions. Failure to notify will make the Contractor liable for damage to these utilities arising from the Contractor's operations subsequent to discovery of such unknown active utilities.
- B. Conduct demolition to minimize interference with adjacent structures or items to remain. Maintain protected egress and access at all times.

1.7 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of 5 years of documented experience.

PART 2 PRODUCTS

2.1 DESCRIPTION

- A. Regulatory Requirements:
 - 1. Code Standards:
 - a. Refer to specification Section 01 41 00 - Regulatory Requirements for code requirements and code standards applicable to all materials and work necessary to complete the scope of work.

PART 3 EXECUTION

3.1 EXISTING CONDITIONS

- A. The Contractor shall acquaint himself with all site conditions. If unknown active utilities are encountered during Work, notify the Architect promptly for instructions. Failure to notify will make The Contractor liable for damage to these utilities arising from the Contractor's operations subsequent to discovery of such unknown active utilities.
- B. Conduct demolition to minimize interference with adjacent structures or items to remain. Maintain protected egress and access at all times.

3.2 SCOPE

- A. As indicated on Drawings.

3.3 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. The Owner has first right of refusal on all salvaged items. Coordinate with the Owner prior to demolition.
- B. Comply with other requirements specified in Section 01 73 00 - Execution.
- C. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
 - 1. Obtain required permits.
 - 2. Comply with applicable requirements of NFPA 241.
 - 3. Use of explosives is not permitted.
 - 4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - 5. Provide, erect, and maintain temporary barriers and security devices.
 - 6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
 - 7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
 - 8. Do not close or obstruct roadways or sidewalks without permit.
 - 9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
 - 10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- D. Do not begin removal until receipt of notification to proceed from the Owner.
- E. Do not begin removal until built elements to be salvaged or relocated have been removed.
- F. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
- G. Protect existing structures and other elements that are not to be removed.
 - 1. Provide bracing and shoring.
 - 2. Prevent movement or settlement of adjacent structures.
 - 3. Stop work immediately if adjacent structures appear to be in danger.
- H. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- I. If hazardous materials are discovered during removal operations, stop work and notify the Architect and the Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
 - 1. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

3.4 PROTECTION

- A. Adequate protection measures shall be provided to protect workmen and passers-by on and off the site. Adjacent property shall be fully protected throughout the operations. Blasting will not be permitted. Prevent damage to adjoining improvements and properties both above and below grade. Restore such improvements to original condition should damage occur. Replace trees and shrubs outside building area disturbed by operations.
- B. In accordance with generally accepted construction practices, Contractor shall be solely and completely responsible for working conditions at the jobsite, including safety of all persons and property during performance of the Work. This requirement shall apply continuously and shall not be limited to normal working hours.
- C. Safety precautions prevent damage to existing elements identified to remain or to be salvaged and prevent injury to the public and workmen engaged onsite. Demolish roofs, walls, and other

building elements in such a manner that demolished materials fall within foundation lines of building. Do not allow demolition debris to accumulate onsite. Pull down hazardous work at end of each day; do not leave standing or hanging overnight, or over weekends:

1. Protect existing items that are not indicated to be altered. Protect utilities designated to remain from damage.
 2. Protect trees, plant growth, and features designated to remain as final landscaping as indicated on Drawings.
 3. Protect bench marks from damage or displacement.
- D. Any construction review of the Contractor's performance conducted by the geotechnical Engineer is not intended to include review of the adequacy of Contractor's safety measures in, on, or near the construction site.

3.5 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.6 PREPARATION

- A. Scheduling:
 1. General: Coordinate and schedule demolition work as required by the Owner and as necessary to facilitate construction progress.
- B. Hazardous Materials:
 1. General: Identify chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations, and notify such jurisdictional agencies as may be required. Collect and legally dispose of such materials at official disposal locations away from the site.
 2. Asbestos: If asbestos or materials containing asbestos are encountered, stop work immediately and contact the Owner. Do not proceed with demolition until directed by the Owner.
- C. Utility and Service Termination:
 1. Locate and identify existing utility, service, and irrigation system components affected by Work of this Contract. Review existing record Drawings, conduct site investigations, contact Underground Service Alert and other qualified cable/pipe/line locator services, and implement all other means necessary to define the location of underground systems.
 2. Prior to beginning any demolition, properly disconnect all water, gas, and electrical power supply at appropriate disconnect locations. Obtain all necessary releases and approvals from serving utility companies.
 3. Prior to demolition or disconnect, obtain the Owner's approval that such system does not impact facilities or systems beyond the extent of this Contract.
 4. Mark location of disconnected systems. Identify and indicate stub-out locations on Project record documents.

- D. Verify that existing plant life and features designated to remain are tagged or identified.
 - 1. The Architect will mark the features, trees, and shrubs to remain within the construction area. The Contractor shall not commence clearing and grubbing operations until authorized by the Owner and all protective measures are in place.
- E. Coordinate the time and duration of all system disconnects with the Owner.

3.7 DEMOLITION

- A. General Requirements:
 - 1. Clear areas required for access to site and execution of Work, including pavement, structures, foundations, vegetation, trash, and debris.
 - 2. Coordinate with the Owner the time of day and route to remove demolished materials from premises.
 - 3. Remove demolished materials from site as work progresses. Upon completion of work, leave areas of work in clean condition.
 - 4. Remove all buried debris, rubble, trash, or other material not deemed suitable by the geotechnical Engineer.
 - 5. Fill all voids or excavations resulting from clearing, demolition, or removal of vegetation with specified fill material.
- B. Fixture and Equipment Removal:
 - 1. Remove existing fixtures and equipment as identified and shown on Drawings and required by the Architect.
 - 2. Verify all service connections to fixtures and equipment designated for removal have been properly disconnected.
 - 3. Remove all conductors from conduit at all abandoned circuits.

3.8 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Architect before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Remove existing work as indicated and as required to accomplish new work.
 - 1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction.
 - 2. Remove items indicated on Drawings.
- C. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and _____): Remove existing systems and equipment as indicated.
 - 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 - 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - 3. Refer to Section 01 10 00 - Summary for other limitations on outages and required notifications.
 - 4. Verify that abandoned services serve only abandoned facilities before removal.
 - 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- D. Protect existing work to remain.
 - 1. Prevent movement of structure; provide shoring and bracing if necessary.
 - 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.

3. Repair adjacent construction and finishes damaged during removal work.
4. Patch as specified for patching new work.

3.9 UTILITY AND BUILDING SERVICES REMOVAL AND RE-INSTALLATION

- A. Where crossing paths and potential points of interference with existing utility services are shown or can be reasonably inferred from surface conditions or evidence of subsurface systems, such as meter boxes, vaults, relief vents, cleanouts, and similar components:
 1. Review all Contract Documents showing crossing paths and potential points of interference.
 2. Pot-hole or determine by other means the accurate depth and location of such utilities.
 3. Incorporate all costs required to complete work under this Contract, including additional trenching, re-routing of existing and new utilities, and all means necessary to construct work under this Contract.
 4. No additional cost to Owner will be allowed for work necessary to accommodate utility conflicts where such crossing paths are shown on Contract Drawings or can be reasonably inferred from surface conditions or components.
- B. Remove all conductors from conduit at all abandoned electrical circuits.
- C. Seal off ends of all piping, drains, and other components as directed by Architect and serving utility.
- D. Where necessary to maintain service to existing utility and building systems, relocate or redirect all conduit and conductors, piping, drains, and associated system components:
 1. Re-circuit all electrical as required.
 2. Re-circuit all landscape irrigation valving and control systems as required.
 3. Temporarily terminate landscape system components in approved boxes or with approved caps, suitable for re-connection or extension.
 4. Extend or otherwise modify all site drainage systems, including catch basins, drain inlets, and piping. Fine grade to maintain proper drainage flow pattern to drains.
- E. Demolish structure in an orderly and careful manner:
 1. Use of explosives prohibited.

3.10 DEBRIS AND WASTE REMOVAL

- A. Demolished materials become property of the Contractor and shall be removed from premises, except those items specifically listed to be retained by the Owner.
- B. Remove debris, junk, and trash from site on a daily basis.
- C. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Construction Waste Management and Disposal.
- D. Leave site in clean condition, ready for subsequent work.
- E. Clean up spillage and wind-blown debris from public and private lands.

3.11 CLEANING

- A. Upon completion of work of this Section, promptly remove from the working area all scraps and debris.
- B. Clean excess material from the surface of all remaining paved surfaces and utility structures.
- C. Power wash all concrete surfaces to remove stains, dried mud, tire marks, and rust spots.

END OF SECTION 02 41 00

SECTION 02 41 13 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Partial demolition of existing building as required to accommodate additions and renovations as shown on the drawings or required. Include removal of existing utilities as indicated or encountered; removal of masonry, and mechanical, electrical, and plumbing items as indicated or required.

1.2 SUBMITTALS

- A. Submit the following items.
 - 1. Itemized Demolition Schedule.
 - 2. Detail all demolition methods to be used.

1.3 PERMITS

- A. Procure and pay for all necessary permits or certificates required to complete the work specified. Make any and all required notifications and comply with all applicable Federal, State and local ordinances.

1.4 QUALITY ASSURANCE

- A. Provide at least one (1) person who shall be present and in charge of the Demolition Work at all times and who shall be thoroughly familiar with all phases of all work performed under this Section.
- B. Comply with all pertinent codes and regulations applying to this work.

1.5 JOB CONDITIONS

- A. Use all means necessary to prevent the spread of dust during performance of this work. Provide additional clean filters for the existing air handling system serving those areas to remain to protect them from construction dust.
- B. Use all means necessary to protect the existing building to remain from all types of damage, including fire, water damage, and unnecessary interruption of utility services. In the event of damage of any kind, immediately make all repairs and replacements necessary to the approval of the Owner at no additional cost to the Owner.
- C. Motor driven equipment shall have functional mufflers.
- D. Visit the site and examine the existing structure. Note all conditions as to the character and extent of work involved.

1.6 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 - Notification of Architect requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide all barricades, shoring, and bracing necessary to protect the tenants, workmen, and Public from danger. Barricades shall be sufficiently designed to protect and or exclude the public from all hazards.
- B. All other materials, not specifically described but required for proper completion of Work of this Section, shall be as selected by the Contractor subject to the approval of the Owner.

2.2 DEMOLITION WORK

- A. Perform demolition work in manner so as to allow Owner's safe use of existing facility.
- B. Perform demolition work in order to maintain Owner's construction schedule.

2.3 REMOVAL OF PARTITIONS, COLUMNS AND STRUCTURE

- A. Masonry walls or other sections of masonry shall not be permitted to fall on floors of building in masses to exceed safe carrying capacity of floors. Existing floors shall be properly protected with plywood on both sides of a partition to be demolished.
- B. Provide temporary shoring or bracing wherever necessary for the protection of occupants, workmen, walls, partitions, roofs, floors and structure to remain.
- C. Structural or load-supporting members shall not be cut or removed adjacent to existing structures to remain until all loads carried by members have been removed or adequately supported.
- D. No masonry walls shall be removed until it has been determined that the walls to be removed do not support the roof. To determine this, all adjacent materials such as finish ceilings shall be removed to provide adequate views of existing structure. Provide temporary shoring as needed. The Contractor shall take all precautions necessary to ensure the safety of the demolition workers and all occupants of the building.
- E. No demolition will be allowed above, below, adjacent to or near any occupied areas of the building.
- F. Where access holes in existing ceilings or removal of existing ceilings are required, minimize the access in order to minimize the repair work and repair or replace removed or damaged work to match adjacent undamaged work.
- G. Cut and tooth new openings in masonry where required, of correct size to permit installation of frames and anchors for new doors.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Before commencing the Work of this Section, verify with the Owner that all items to be removed by the Owner have been removed. Schedule the work in a careful manner with all necessary consideration for the Public and the Owner. All items of existing equipment

and materials or any other item of value to the Owner shall be salvaged by the Owner prior to demolition.

- B. All material removed under this Contract, which is not to be salvaged or reused, shall become the property of the Contractor and be promptly removed from the site. At all times use movable debris boxes, covered, to convey the material through the building. Do not store or permit debris to accumulate on the site. Dumpsters shall not overflow and shall be emptied on a regular basis. Remove all debris from the building premises and leave the construction site "Clean" each day. All debris shall be dumped in an approved disposal facility and all fees for this shall be paid by the Contractor. Contractor is responsible for completely removing all demolished materials from the site and disposing of them in accordance with all local, State and Federal Regulations. If Contractor fails to remove debris promptly, Owner reserves the right to have debris removed at Contractor's expense.
- C. Conduct operations so as not to interfere with adjacent occupied spaces, roads, streets, drives, walks, service lines and the like.
- D. Keep all pedestrian areas clear for passage at all times.

3.2 PROTECTION OF STRUCTURES, PROPERTY

- A. Execute demolition work to ensure adjacent property no damage from falling debris or other causes.
- B. Take precautions to guard against movement, settlement, or be liable for such movement, settlement, or collapse; repair promptly such damage when so ordered.
- C. Repair damage to Owner's property or any other person or persons on or off premises by reason of required work.

END OF SECTION 02 41 13

SECTION 02 41 13.23 - ABANDONMENT OF EXISTING UTILITIES

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

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SUMMARY

- A. Abandon water lines, storm and sanitary sewers, manholes, and associated appurtenances as indicated on the Plans in accordance with the methods outlined herein.

1.2 PAYMENT

- A. Payment will be made if an item is provided for such on the bid form; otherwise, include cost of work in the lump sum price.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Specific products are not required. Reference other applicable sections of the specifications for material required.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate all work so that existing utilities are operable until new utilities are complete and in place. Keep any service interruptions to a minimum.

3.2 WATER LINE ABANDONMENT

- A. Remove at least one joint of existing pipe where crossing or tying-in with new water lines. Plug both ends of abandoned line with an appropriate manufactured fitting (cap or plug) or fill end of line with 3000 psi concrete. Backfill as per SECTION 31 23 00 - CONSTRUCTION OF UNDERGROUND UTILITIES.

3.3 SEWER ABANDONMENT

- A. Unless noted on drawings to be removed, abandon sewers 12 inches in diameter and smaller by filling with a liquid concrete slurry composed of a 3 sack per cubic yard mix using pea gravel (1-1/2 inch and smaller aggregate) or drilling mud. Limit length of application to individual sections between manholes. Construct a temporary dam in downstream manholes above top of pipe. Pour slurry or mud in upstream manhole or in riser pipe attached to upstream end of sewer. Fill line till slurry or mud rises above top of pipe on both ends.
- B. Sewers between 12" – 36" in diameter shall be abandoned in accordance with either 3.3.A or 3.3.C.
- C. Unless noted on drawings to be removed, abandon sewers 36 inches in diameter and larger by breaking in top of pipe and backfilling. Excavate and expose top half of existing sewer. Using appropriate equipment, cave-in the top half of pipe; as a minimum, the upper 120-degree section of pipe must be broken in. Fill open pipe with backfill material and compact to top of existing pipe. Backfill to grade in accordance with SECTION 31 23 00 - CONSTRUCTION OF UNDERGROUND

ABANDONMENT OF EXISTING UTILITIES

UTILITIES.

3.4 MANHOLE ABANDONMENT

- A. After abandoning sewer lines in the appropriate manner, fill manholes to be abandoned with bank sand. Excavate around top of manhole and remove manway (reducer) section of manhole. Fill manhole with bank sand in 12-inch compacted lifts to top of manhole barrel. Backfill to finished grade in accordance with SECTION 31 23 00 - CONSTRUCTION OF UNDERGROUND UTILITIES.

END OF SECTION 02 41 13.23

SECTION 02 82 00 - ASBESTOS REMEDIATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The provisions of the General Conditions, Supplementary Conditions, Drawings, Specifications, and the Sections included under Division 01 General Requirements and References, are included as a part of this Section as though bound herein.

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Asbestos material abatement and disposal.
 - 2. Accessories necessary for complete removal.
- B. Related Sections:
 - 1. Section 02 41 00 - Demolition.

1.3 REFERENCE STANDARDS

1.4 SUBMITTAL

- A. Submit one copy of the signed waste manifests indicating the place, time and exact quantity of asbestos, received by an approved landfill.

1.5 QUALITY ASSURANCE

- A. Qualifications: Entity having minimum 5 years documented experience, holding required current licenses for the removal, transport, and disposal and related activities relative to the work, having the required personal protective equipment and respirators for abatement operations, with current liability insurance, and who employs workers fully trained and knowledgeable in the removal of hazardous materials.
- B. Stop Asbestos Removal
 - 1. If a verbal or written Stop Asbestos Removal Order is given, immediately stop asbestos removal and maintain HEPA filtered negative pressure air flow in the containment and adequately wet any exposed Asbestos Contained Material (ACM).
 - 2. Do not resume asbestos removal activity until authorized to do so in writing by the Owner.
 - 3. A Stop Asbestos Removal Order may be issued at any time by the Owner if it is determined that abatement conditions/activities are not within regulatory requirements or that an imminent hazard exists to human health or the environment.
 - 4. Work stoppage will continue until conditions have been corrected.

PART 2 MATERIALS

2.1 DESCRIPTION

- A. Regulatory Requirements:
 - 1. Code Standards:
 - a. Refer to specification Section 01 41 00 - Regulatory Requirements for code requirements and code standards applicable to all materials and work necessary to complete the scope of work.

PART 3 EXECUTION

3.1 REMEDIATION

- A. The Owner has conducted an asbestos survey and has determined that asbestos may be present in areas where work will be performed. The survey is made available for review.
 - 1. As part of the work, the Owner requires asbestos removal to be performed under the construction contract.
 - 2. Asbestos may be present in vinyl tile under architectural woodwork or covered by, but not encapsulated, carpet materials and other types of flooring.

3. Asbestos may be present in the ductwork above the ceiling panels.
 4. If asbestos is found, stop work in the area and engage an asbestos removal firm to remediate the asbestos from the area. Do not resume work in the affected areas until the abatement is complete and authorization to proceed with work in the affected areas is given. Work in areas not affected by asbestos may continue.
- B. Assume responsibility and liability for compliance with applicable Federal, State, and Local regulations related to the asbestos abatement work.
1. Provide and maintain training, accreditations, medical exams, medical records, personal protective equipment (PPE) including respiratory protection including respirator fit testing, as required by applicable Federal, State and Local regulations.
 2. Post required notices prior to the commencement of the work.
 3. Restrict access to containment areas to authorized, trained, and protected personnel.
 4. Prepare and post an emergency plan in clean room and equipment room of the decontamination unit.
 5. Do not permit workers to eat, drink, smoke, chew gum or tobacco, or break the protection of the respiratory protection system in the work area.
- C. Entering and Exiting Procedures: Establish procedures for entering and exiting containment area. Provide personnel decontamination unit with disposable coveralls, head covers, and clean respirators. Provide shower room between personnel decontamination area and equipment room.
- D. Decontamination Procedures: Establish procedures for decontamination upon leaving containment are in accordance with federal and state regulations.
- E. Provide negative pressure filtration systems to complete exchange air 4 time per hour. Provide standby system in the event of a machine failure or emergency.
1. Continuously monitor and record the pressure differential between the work area and the building outside of the work area.
- F. Prepare the Affected Area: Remove furnishings and materials to the extent necessary to remediate the asbestos.
- G. Containment of Areas:
1. Provide a secure containment work area in accordance with federal and state regulations. Avoid damage to existing partitions and ceilings scheduled to remain to the extent possible.
 - a. Establish critical barriers over each opening into the work area.
 - b. Close out vents and air ducts to prevent particulates from entering the HVAC system.
- H. Debris:
1. Place contaminated debris in a designated location within the containment area.
 - a. Place debris in minimum 6 mil poly bags before removing from contaminated areas. Pass Clean or decontaminate bags and pass and pass through a double 6 mil flap doorway into another bag or fiber drum. Remove to disposal dumpster/gondola/vehicle. Do not permit unprotected personnel to come in contact with contaminated bags.
 - b. Remove and dispose of contaminated debris in compliance with local regulations.
- I. Testing: Perform required tests and inspections upon completion of the work. Collect air samples and analyze in accordance with regulations. Upon satisfactory conclusion of testing, remove critical barriers.
- J. After thorough decontamination, complete asbestos abatement work upon meeting the regulated area clearance criteria and fulfilling the following:
1. Remove equipment, materials, and debris from the project area.
 2. Package and dispose asbestos waste as required.
 3. Repair or replace all interior finishes damaged during the abatement work.
 4. Fulfill other project closeout requirements as specified elsewhere in this specification.

3.2 CERTIFICATE OF COMPLETION BY THE CONTRACTOR

- A. Submit a signed Certificate of Completion at the completion of the abatement and decontamination of the regulated area.

END OF SECTION 02 82 00

SECTION 06 10 00

ROUGH CARPENTRY

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All rough carpentry items including, but not limited to:
 - 1. Wood blocking for support of items supported on or recessed into steel and wood framing or requiring wood blocking for support.
 - 2. Wood cants, nailers, curbs, and other items associated with roofing work.
 - 3. Miscellaneous exterior framing items and exterior plywood sheathing.

1.2 RELATED WORK

- A. All Sections of Work supported on or recessed into steel and wood framing or requiring wood blocking for support, such as perimeter edge metal systems, expansion joints, metal and wall trim and fascias, etc., as applicable to the Project.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's data on wood treatment materials.

1.4 STANDARDS AND GRADING

- A. All lumber used structurally shall be graded and marked with grade and trademark of a lumber grading organization approved by the Architect, except that a certification of grade from such a grading organization may be accepted in lieu of grade and trademarks when approved by Architect. Trademark of manufacturer shall also appear on each piece.
- B. Each piece of plywood used structurally shall carry the American Plywood Association trademark.
- C. Grading Rules: Conform with all applicable requirements of American Lumber Standards "Simplified Practice Recommendations R-16" and to grading rules of manufacturer's association under whose rules the lumber is produced.
- D. Reference Standards: Conform with all requirements.
 - 1. U.S. Dept. of Commerce Product Standards (PS)
 - 2. American Plywood Association (APA)
 - a. Standards and Construction Guide
 - 3. American Wood Preservers Association (AWPA)
 - a. Standards, as they apply.
 - 4. Architectural Woodwork Institute (AWI)
 - a. "Quality Standards"
 - 5. National Woodwork Manufacturers' Association (NWMA)
 - a. Standards
 - 6. Western Wood Products Association (WWPA)
 - a. Manual

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Lumber:
1. Treated No. 2, S4S Southern Yellow Pine, #1 kiln dried.
 - a. Comply with NWMA Standards
 - b. Use for blocking, stripping, grounds, cants and miscellaneous wood items in contact with concrete, roofing, or exposed to the weather.
 2. No. 2, S4S Southern Yellow Pine: Use for framing, blocking, stripping and miscellaneous concealed interior lumber not exposed to concrete, roofing weather or moisture, when FRS lumber is not required by building code.
 3. Fire Retardant No. 2, S4S Southern Pine: Refer to Fire Retardant Treatment below. Use for framing, plates and blocking in all walls and partitions where required by building code or noted on drawings.
- B. Plywood:
1. General: Comply with APA Standards.
 2. APA A-D, Group 1 Interior used where appearance of only one side is exposed to view for interior locations. Use for wall liner at MDF/IDF closets and telephone boards in mechanical and telephone rooms where shown or required. 3/4 inch thick unless required or shown otherwise. Paint as scheduled in Section 09 91 00.
 3. Exterior plywood, Group 1, APA rated sheathing. Use where miscellaneous plywood is exposed to concrete, weather, or at roof construction as sheathing.
 4. Fire Retardant Treated Plywood: Refer to Fire Retardant Treatment below. Use when required by building code or noted on drawings.
 5. Underlayment: If shown or required, APA rated Sturdi-floor, exterior grade, tongue and groove edges.
- C. Rough Hardware:
1. Nails, Spikes, and Staples: Galvanized for exterior locations, high humidity locations, and treated wood; plain finish for other interior locations: Size and type to suit application. Do not use to resist "pull-out" loads.
 2. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel; size and type to suit application. Galvanize for exterior locations, high humidity locations, and treated wood. Plain finish for other interior locations.
 3. Fasteners: Toggle bolt type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry and concrete. Bolts or power activated type for anchorage to steel.
- D. Wood Treatment:
1. Preservative Treatment (Concealed Conditions):
 - a. Micronized Copper Azole (MCA): Waterborne, pressure impregnated preservative from a plant licensed by manufacturer in accordance with the following standards:
 - 1) Preservative Treatment Standard: AWP A P5
 - 2) Structural Lumber Treatment Standard: AWP A C31
 - 3) Plywood Treatment Standard: AWP A C9
 - b. Brush two (2) coats of preservative treatment on all saw cut or drilled holes in treated lumber.
 - c. Provide Quality Mark Stamp on treated wood for identification.
 - d. Fasteners: Metal fasteners in contact with preservative treated wood shall be epoxy coated or G-90 galvanized fasteners (minimum), or stainless steel

- in accordance with manufacturer's instructions. Uncoated steel or aluminum shall not come in contact with preservative wood.
- e. Aluminum Contact: Do not allow aluminum to be in direct contact with MCA impregnated wood materials. Provide separation as appropriate to the installation.
 - f. MCQ, ACQ and CCA preservatives not permitted.
 - g. Acceptable Manufacturers: Koppers Performance Chemicals or Osmose "MicroPro" Smart Sense; or Architect approved equal.
2. Fire Retardant Treatment:
- a. Lumber shall be pressure-impregnated with non-combustible fire retardant chemicals in accordance with U.L. FRS Fire Hazard Classification. All lumber must be dried following treatment in accordance with AWPA Standard C20.
 - b. Plywood shall be pressure-impregnated with non-combustible fire retardant chemicals in accordance with U.L. FRS Fire Hazard Classification. All plywood must be dried following treatment in accordance with AWPA Standards C27.

PART 3 - EXECUTION

- A. Wood Framing:
- 1. Framing and blocking shall be accurately cut and fitted true to line and levels, avoiding shims and wedges.
 - 2. Spiking and nailing shall be done using largest size spikes and nail practicable.
 - 3. Unless otherwise shown, use 2 inch by 4 inch wood studs spaced 16 inches o.c. with 4 inch face perpendicular to direction of wall or partition. Provide single bottom plate and double-top plates 2 inches thick by width of studs.
 - 4. Bolt nailers and blocking to steel, masonry or concrete members with bolts or proportionate strength of members attached from each end, except as otherwise noted on plans.
 - 5. Provide blocking, bucks and framing as necessary and for other trades as required.
 - 6. Drill lumber accurately for bolts and fit all bolts with suitable washers.
 - 7. Perimeter wood blocking to be attached 2'-0" staggered with 1/2" galvanized bolts through both nailers.
 - 8. Screws are to be used for perimeter edge nailers. No nailing permitted.
- B. Plywood:
- 1. Install plywood over framing in accordance with instruction of American Plywood Association Construction Guide Form No. E30C.
 - 2. Install underlayment plywood as shown in accordance with instructions of American Plywood Association. Space panel joints and edges 1/32 inch. Fill and sand panel edge joints, surface roughness, and damaged or open areas. Nail with 4d ring-shank nails spaced at six (6) inches at edges and eight (8) inches in field each way.

END OF SECTION

SECTION 07 52 20 - MODIFIED BITUMEN “COOL ROOF” MEMBRANE ROOFING SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Providing coordination for the entire roofing assembly, including, but not limited to:
 - 1. Tapered edge strips, cant strips, and wood nailers. (Refer to this Section and Section 06 10 00)
 - 2. Modified bitumen membrane roofing
 - 3. Flashings, including sheet metal perimeter edge (fascia) (Refer this Section and Section 07 62 00).
 - 4. Work incidental to, the complete and proper installation of a watertight modified bitumen membrane roofing system as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.
- B. It is the intent of this Section that the Work shall:
 - 1. provide a watertight facility;
 - 2. conform to all applicable building code requirements and of authorities having jurisdiction;
 - 3. include Section 07 62 00, Roof Related Sheet Metal as part of the Work of this Section; and be performed to obtain a single responsibility total system warranty.
- C. Work and materials hereinafter specified shall be best of kind described and, unless specified otherwise, shall be new and of best quality. All roofing materials utilized in performance of each type of work shall be the products of one (1) manufacturer or supplier.

1.3 RELATED WORK

- A. All Sections of Work relating to the roofing system, including mechanical, plumbing and electrical items penetrating the roof system.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. C920, Standard Specification for Elastomeric Joint Sealants
 - 2. D41, Standard Specification for Asphalt Primer Used in Roofing, Damproofing, and Waterproofing
 - 3. D312, Standard Specification for Asphalt Used in Roofing
 - 4. D2178, Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
 - 5. D4479, Standard Specification for Asphalt Roof Coatings - Asbestos-Free
 - 6. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free
 - 7. D4601, Standard Specification for Asphalt-Coated Glass Fiber Sheet Used in Roofing

8. D5147, Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
 9. D4897, Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
 10. D6163, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
- B. ASCE-16 Wind uplifts requirements for geographical area.
- C. Federal Specifications (FS)
1. SS-R-620B
 2. TT-S-00230C
- D. National Roofing Contractors Association (NRCA)
1. Roofing and Waterproofing Manual
- E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
1. Architectural Sheet Metal Manual
- F. International Building Code
- G. Underwriters' Laboratories (UL)
1. Fire Hazards Classifications

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's printed instructions, schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, fastener pattern layout, and accessories to be used in the Work.
- B. Certifications:
1. Manufacturer's written certification that installer is approved and licensed to install specified roofing system.
 2. Manufacturer's affidavit that materials used in Project contain no asbestos.
 3. Installer shall submit resume and project experience list for proposed system for Project Manager and job site superintendent.
 4. Installer shall submit written certification that there are no undocumented workers being employed by them or by any subcontractor on this project and that all workers on this project are covered by workmen's compensation.
 5. Installer shall submit list of all subcontractors with evidence of subcontractor's insurance coverage in compliance with contract requirements.
 6. Manufacturer's written certification of approval / acceptance of these specifications and details.
 7. Warranty: Submit letter from manufacturer signed by agent authorized to do so, stating acceptance of warranty as specified and detailed.
- C. Referenced Standards: Two (2) copies of each referenced standard and retain approved copies at site.
- D. Shop Drawings: Furnish from copies of the manufacturer's literature or from copies of NRCA "Roofing and Waterproofing Manual", fourth edition.
1. Furnish for approval any proposed details which differ from those included with this proposal package. All proposed details shall first be approved in writing by roofing manufacturers prior to submitting to Architect for approval.

2. Furnish detail project sequencing, staging, material loading, manpower plans, and project construction schedule for approval.
- E. Samples:
 1. Submit sample copy of job specific warranty that is to be issued upon project completion.
 2. Submit mock-up of all fabricated sheet metal items.
 3. Submit 12-inch x 12-inch sample of all types of roof membranes to be installed.
- F. Temperature Charts: Bitumen heating devices 24-hour temperature charts.
- G. Test Reports: Bitumen manufacturer's test reports relating to the following for each batch of bitumen furnished:
 1. Softening Point: ASTM D312.
 2. Flashpoint: ASTM D92.
 3. Acceptable Bitumen Temperature: As recommended by the bitumen manufacturer and EVT label on containers.
 4. Thermometers: Two (2) handheld, "8F" thermometers complying with ASTM E1 to Architect for his checking kettle temperature.
- H. Upon Substantial Completion of Work, submit the following to Architect for his submission to Owner:
 1. Manufacturer's Warranty: Manufacturer's written warranty as specified.
 2. Maintenance Procedures: Three (3) copies of manufacturer's printed instructions for Owner's use regarding care and maintenance of roof.

1.6 PROJECT CONDITIONS

- A. Weather Condition Limitations: Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements. Roofing applications with moisture present will not be accepted. Do not attempt construction of the roofing system when the reported temperature or calculated dew point are within three (3) degrees of each other
- B. Do not allow waste products, petroleum, grease, oil solvents, mineral oil, and other contaminants to come into contact with the roofing system before or during installation. Advise Owner if there is a possibility of his facility emitting such contaminants in the future.

1.7 INSPECTIONS / TESTS

- A. The Architect's and Manufacturer's representative shall at all times have access to the job site and work areas. The contractor will provide proper and safe facilities for such access and inspection.
 1. Architect Inspections: The Architect will be providing periodic inspections throughout the duration of the project. Architect's Representative shall be required to inspect after completion of each major phase of construction for approval.
 2. Manufacturer Inspections:
 - a. An inspection shall be made by a representative of the material manufacturer at appropriate intervals during performance of Work to ensure that said project is installed in accordance with the manufacturer's specifications and illustrated details. Written reports by the manufacturer shall be turned over to the Architect, on each Monday following the prior week.

- b. The authorized material manufacturer's field representative shall be responsible for:
 - 1) Keeping the Architect's representative informed after periodic inspections as to the progress and quality of the work observed.
 - 2) Calling to the attention of the contractor those matters observed which are considered to be in violation of the contract requirements.
 - 3) Reporting to the Architect's representative, in writing, any failure or refusal of the contractor to correct unacceptable practices called to his attention.
 - 4) Confirming, after completion of the work and based on his observation and test, that he has observed no application procedures in conflict with these specifications.
- B. Any failure by the Architect's or Manufacturer's Representative to detect, pinpoint, or object to any defect or noncompliance of these specifications of work in progress or completed work shall not relieve the contractor, or reduce, or in any way limit his responsibility of full performance of work required of him under these specifications.
- C. Architects may require tests and inspections as necessary to verify quality of roofing materials and workmanship. Laboratory tests will be performed in accordance with ASTM standard procedures.
 - 1. Owner will select testing laboratory and will pay for Work required by testing laboratory.
 - 2. Re-tests for work which fail initial tests or inspections shall be paid by contractor.
 - 3. Noncompliance with contractor requirements will result in the Architect/Owner to assign full-time quality control and will be subject to reimbursement by the construction manager/contractor.

1.8 QUALITY ASSURANCE

- A. Applicator:
 - 1. Applicator shall have approval by manufacturer of accepted roofing system for application and issuance of specified warranty for a minimum of three (3) years. Proof of license agreement dated at least three years prior to date of bid opening.
 - 2. Applicator shall be an experienced single firm specializing in the type of roofing and sheet metal work specified, with a minimum of five (5) years of previous successful experience on projects similar in size and scope.
 - 3. No subcontracting of sheet metal fabrication or installation will be accepted. Contractor must have a sheet metal shop on the company premises.
 - 4. Applicators shall have a competent Superintendent, who is not actually performing roofing work, on site at all time while work is in progress, with full authority to act on behalf of the Contractor as his agent.
 - 5. All workmen shall be covered by Workmen's Compensation insurance (verify upon request) and thoroughly experienced in the particular class of work upon which employed. Use of undocumented workers will not be tolerated - No Exceptions.
 - 6. Contractor shall ensure that base fastener pull out resistance tests on existing decks were performed and approved by Architect and coordinated with Roofing Consultant prior to starting roofing application.
 - 7. Roofing contractors must have reached the highest level of qualifications from the manufacturer they are providing material for (i.e. Master Select contractor).
- B. Regulatory Requirements:
 - 1. Classification by Underwriters' Laboratories, Inc. as a Class A roof covering.

2. Roofing systems shall be installed in accordance with ASCE-16 wind uplift requirements for geographical location exposure C, 140 MPH 3-second gust wind speed zone and risk category II based on IBC building code requirements. Wind-resistance loads listed below have a safety factor of 2.0 incorporated into the calculation.
 3. Follow local, state, and federal regulations of safety standards and codes. Refer to applicable building code or International Building Code for roofing system installation requirements and limitations.
 1. Zone 1' Interior 50.0 psf or as otherwise included by Structural
 2. Zone 1 Field 87.0 psf or as otherwise indicated by Structural
 3. Zone 2 Perimeter 114.8 psf or as otherwise indicated by Structural
 4. Zone 3 Corner 156.4 psf or as otherwise indicated by Structural
- C. Texas State Board of Insurance Windstorm Regulations: Owner will provide inspector to meet all requirements. Contractors to coordinate all applicable roof inspections with Owners Inspector.
- D. Laboratory Testing and Samples:
1. Architect may require tests and inspections as necessary to verify quality of roofing materials and workmanship. Laboratory tests will be performed in accordance with ASTM procedures.
 2. Owner will select testing laboratory and will pay for Work required by testing laboratory. Contractor shall assume all costs for extraction and patch of all samples.
 3. Re-tests for work which fail initial tests or contractor shall pay inspections.
 4. Contractor shall correct all deficiencies in accordance with manufacturers recommended procedures at no cost to Owner.
- E. Installation:
1. Unless otherwise indicated, the materials to be used in this specification are those specified and denote the type, quality, performance, etc. required. All proposals shall be based upon the use of the specified material.
 2. Install materials in accordance with the manufacturer's current published application procedures and the general recommendations of the National Roofing Contractor's Association.
 3. It will be the contractor's responsibility to obtain and/or verify any necessary dimensions by visiting the job site, and the contractor shall be responsible for the correctness of it. Any drawings supplied are for reference only.
 4. Contractor shall plan and conduct the operations of the work so that each section started on one day is complete, details installed and thoroughly protected and in watertight condition before the close of work for that day.
 5. Materials will be securely fastened in place in a watertight, neat and workmanlike manner. All workmen shall be thoroughly experienced in the particular class of work upon which employed. Work shall be performed in accordance with these specifications and shall meet the approval in the field of the Architect.
 6. All waste materials, rubbish, etc., shall be removed from the Owner's premises as accumulated. Rubbish shall be carefully handled to reduce the spread of dust and shall be deposited at an approved disposal site. At completion, all work areas shall be left broom clean, and all contractors' equipment and materials removed from the site.

1.9 PERFORMANCE REQUIREMENTS

- A. Texas State Board of Insurance Windstorm Regulations: Owner will provide inspector to meet all requirements. Contractors to coordinate all applicable roof inspections with Owners Inspector.
- B. Fire Resistance: Meet Underwriter's Laboratory Class "A" fire rating.
- C. Contractor shall ensure that base fastener pull out resistance tests on new lightweight insulating concrete fill were performed and approved by Architect and coordinated with Roofing Consultant prior to starting roofing application.

1.10 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original unopened packaging with all tags and labels intact and legible. Carton and can labels shall indicate appropriate warnings, storage conditions, lot numbers, and usage instructions. Handle and store materials and equipment in such a manner as to avoid damage. Coordinate material storage with school Principal.
- B. Manufacturer's packaging and / or roll plastic is not acceptable for exterior storage. Tarpaulin with grommets shall be minimum acceptable for exterior coverings. All materials stored as above shall be minimum of four (4) inches off the substrate, and the tarpaulin tied off with rope.
- C. Products liable to degrade as a result of being frozen shall be maintained above 40 degrees F in heated storage.
- D. Moisture sensitive products shall be maintained in dry storage areas or properly covered. Roofing insulation and felts must always be covered or stored in a dry area when not being used.
- E. The proper storage of materials is the sole responsibility of the contractor. Materials damaged in shipping or storage shall not be used. Wet or damaged roofing materials shall be discarded, removed from job site, and replaced with new materials prior to application.
- F. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

1.12 PRECAUTIONS

- A. Some of the indicated materials are extremely flammable and/or toxic. Use precautions indicated on can and carton labels.
- B. Due caution should be exercised so as not to alter the structural integrity of the deck. When cutting through any deck, care should be taken so as not to damage the deck or any part of the deck, such as post tension cables, etc.

- C. If torches are used, Contractor shall maintain a three (3) hour fire watch after completion of torching of each day's work. Provide a 20 lb. fire extinguisher near torch at all times. Use a thermal infrared thermometer to monitor all roof areas.
- D. The contractor is to verify the location of all interior ducts, electrical lines, piping, conduit, and/or similar obstructions. The contractor is to perform all work in such a manner as to avoid contact with the above-mentioned items.

1.13 WARRANTY

- A. Roofing Manufacturer: Warrant the roofing and associated Work for 20 years from date of Substantial Completion as follows:
 - 1. The warranty shall be a NDL "No Dollar Limit" / no penal sum type, with total replacement cost.
 - 2. The warranty shall guarantee the entire roof system and associated work against defective materials and workmanship of installation, with NO exclusion for ponding water.
 - 3. The roof system shall include roof insulation, flashing, metal work, labor, and materials shall be guaranteed against failure of workmanship and materials. Repair of the system, including materials and labor, shall be done at no cost to the Owner.
- B. Roofing Contractor: Jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Architect accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the Contractor, and subcontractors, to make good the requirements of the warranty. The warranty will be held jointly with the Bonding Company for the first two (2) years and the manufacturer for the remaining three (3) years.
- C. Make arrangements with the materials manufacturer to provide required inspections for issuance of warranty. Final warranty shall be submitted to Owner at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall be manufactured, specified, or accepted in writing by membrane manufacturer issuing the warranty. Proposed materials shall ensure full system warranty from said manufacturer.
- B. Samples of materials used on the project, which are not supplied by the membrane manufacturer, shall be submitted to the membrane manufacturer for written approval prior to starting work.
- C. Materials used on the project shall be asbestos free.

2.2 APPROVED PRODUCTS/MANUFACTURERS

- A. Unless noted otherwise, specifications are based on products of named manufacturers but should not preclude the Contractor from using other manufacturers who produce products that meet or exceed the specifications. Manufacturers whose products meet or exceed the specifications, who have manufactured and installed roof materials and systems of the type specified for a minimum of ten (10) years, and who maintains a single source responsibility for the total roofing system, as described herein, may apply for approval as a substitution in accordance with Division 1 requirements regarding substitutions.
1. All materials shall be manufactured, specified, or accepted in writing by membrane manufacturer issuing the warranty. Proposed materials shall ensure full system warranty from said manufacturer. Installer shall be an applicator licensed by the manufacturer.
 2. Samples of all materials used on the project, which are not supplied by the membrane manufacturer, shall be submitted to the membrane manufacturer for written approval prior to starting work.
 3. All materials used on the project shall be asbestos free.
- B. Approved Manufactures:
1. GAF, Parsippany, NJ; (973) 628-3000
 1. Siplast, Inc., Irving, Texas; (972) 869-0070
 2. Soprema, Wadsworth, OH; (800) 356-3521
 3. Elevate Building Products Company, Nashville, TN; (800) 428-4442

2.3 ROOFING SYSTEM ASSEMBLY/PRODUCTS

- A. Modified Base Sheet: A fiberglass reinforced, Styrene-Butadiene-Styrene (SBS) modified asphalt coated sheet, having an average weight of 28 pounds per square.
1. Approved Product:
 - a. GAF Product: GAF Glass 75, base sheet
 - b. Siplast Product: Para Base, base sheet
 - c. Soprema Product: Sopra-G, base sheet
 - d. Elevate Product: MB Base, base sheet
- B. Dry Sheathing Paper: (For use as a slip sheet) Rosin coated, 5 lbs. per 100 sq. ft.

2.4 ROOF MEMBRANE ASSEMBLY

- A. System Description: A roof membrane assembly consisting of two (2) plies of a prefabricated, reinforced, homogeneous polymer modified asphalt membrane, secured to specified insulation or substrate. The assembly shall possess waterproofing capability, such that a phased roof application, with only the modified bitumen base ply in place, can be achieved for prolonged periods of time without detriment to the watertight integrity of the entire roof system. Contractor option to install using hot asphalt "mopped", torched, or any combination – confirm special membrane types with manufacturer. Provide components of the roof membrane assembly meeting the following physical and mechanical requirements.
1. **Hot Asphalt Applied Modified Bitumen Base Ply:** Approximately 90 mil high performance modified bitumen base ply consisting of a lightweight random fibrous glass mat impregnated and coated with high quality modified bitumen and having the following properties:
 - a. Approved Product:
 1. GAF Product: Rubberoid 20

2. Siplast Product: Paradiene 20
 3. Soprema Product: Elastophene Sanded 2.2
 4. Elevate Product: SBS Base
2. **Torch Applied Modified Bitumen Base Ply: Approximately** 120 mil high performance modified bitumen base ply consisting of a lightweight random fibrous glass mat impregnated and coated with high quality modified bitumen and having the following properties:
 - a. Approved Product:
 1. GAF Product: Rubberoid 30 HW Smooth
 2. Siplast Product: Paradiene 20 TG
 3. Soprema Product: Elastophene Flam
 4. Elevate Product: SBS Glass Torch Base
3. **Hot Asphalt Applied Modified Bitumen Finish Ply:** Approximately 130 mil or better high-performance modified bitumen “cool roof” reflective white finish ply consisting of a lightweight random fibrous glass mat impregnated and coated with high quality Styrene-Butadiene-Styrene (SBS) modified bitumen, and having the following properties:
 - a. Approvals: UL Approved, FM Approved (products shall bear seals of approval)
 - b. Surfacing: White synthetic chips
 - c. Solar Reflectance (avg.): greater than 3 years aged .75
 - d. Thermal Emittance (avg.): greater than 3 years aged .75
 - e. Solar Reflectance Index (avg.): greater than 3 years aged 64
 - f. Approved Product:
 1. GAF Product: Rubberoid Energy Cap 30 Granule FR
 2. Siplast Product: Paradiene 30 FR BW
 3. Soprema Product: Elastophene LS FR GR SG
 4. Elevate Product: DynaGlas FR CR G
4. **Torch Applied Modified Bitumen Finish Ply:** Approximately 140 mil or better high-performance modified bitumen “cool roof” reflective white finish ply consisting of a lightweight random fibrous glass mat impregnated and coated with high quality Styrene-Butadiene-Styrene (SBS) modified bitumen, and having the following properties:
 - g. Approvals: UL Approved, FM Approved (products shall bear seals of approval)
 - h. Surfacing: White synthetic chips
 - i. Solar Reflectance (avg.): greater than 3 years aged .75
 - j. Thermal Emittance (avg.): greater than 3 years aged .75
 - k. Solar Reflectance Index (avg.): greater than 3 years aged 64
 - l. Approved Product:
 - 1) GAF Product: Energy Cap BE HW 30 BW
 - 2) Siplast Product: Paradiene 30 FR TG BW
 - 3) Soprema Product: Elastophene Flam LS FR GR SG
 - 4) Firestone Product: SBS Glass FR Torch Ultrawhite
5. Stripping Ply: Same as roof system base ply.

2.5 FLASHING MEMBRANE ASSEMBLY

- A. A flashing membrane assembly consisting of two (2) plies of reinforced, polymer modified asphalt membrane:
 - 1. Modified Bitumen Flashing Sheet: Same as roof system finish ply.
 - 2. Reinforcing Ply: Same as roof system base ply.

2.6 ROUGH CARPENTRY

- A. All nailers, cants and wooden curbs shall be No. 2 or better treated lumber selected to meet design details and field dimensions and requirements of Section 06 10 00, Rough Carpentry. MCQ and MCA only.

2.4 ROOFING SHEET METAL

- A. Refer to Section 07 62 00, Roof Related Sheet Metal.

2.5 ROOF INSULATION

- A. Roofing Insulation:
 - 1. All insulation shall be approved in writing by the membrane manufacturer as to thickness, type, and manufacturer. All insulation must be approved for the specific application with UL and FM Global approval.
 - 2. Cover Board: Factory cut 96 inches x 48 inches $\frac{1}{2}$ " high density polyisocyanurate board; ASTM C1289, UL Class A, Type 2 Class 4 Grade 1 with a 80-psi minimum compressive strength.
 - 3. ISO Insulation: Factory cut 96 inches x 48 inches polyisocyanurate board; 1 layer 1"; ASTM C1289, UL Class A, Type 2 Class 2 Grade 3 with a 25-psi minimum compressive strength. Approved products shall be Tapered RESISTA manufactured by Elevate or pre-approved equal.
 - 4. Tapered ISO. Insulation: Factory cut 48 inches x 48 inches polyisocyanurate board cut to 1/4 inch per foot slope; thickness varies; ASTM C1289, UL Class A, Type 2 Class 2 Grade 3 with a 25-psi minimum compressive strength. Approved product shall be Tapered RESISTA manufactured by Elevate or pre-approved equal. Provide $\frac{1}{2}$ -inch recovery board similar to that specified above over tapered polyisocyanurate board insulation if used.
 - 5. Tapered Edge Strip: 1-1/2 inches to 0 inches (or as required, field verify), 18 inches x 48 inches, install at all expansion joints, curbs, projections, crickets, saddles and base flashings. Approved material shall be as manufactured by Cant Products or pre-approved equal.

2.6 ROOFING ACCESSORIES

- B. Membrane Roofing Adhesives other than torch option:
 - 1. Mopping Asphalt: Asphalt that has been certified for full compliance with the requirements for Low Fume Type IV asphalt listed in Table I, ASTM D312. Each container or bulk shipping ticket shall indicate the equiviscous temperature EVT, the finished blowing temperature, FBT, and the flash point, FP.
 - a. Approved Product: Trumbull Low Fume asphalt or as required by membrane.
- C. Insulation Adhesives:
 - 1. Low Rise foam as per manufacturers requirements.
- D. Bituminous Cutback Materials:
 - 1. Primer: A high flash, quick drying, asphalt solvent blend which meets or exceeds ASTM D41 requirements.

2. Plastic Cement: An asphalt cutback mastic, reinforced with non-asbestos fibers, used as a base for setting metal flanges and conforming to ASTM D4586 Type II requirements.
 3. Flashing Cement: A heavy-bodied all-weather trowel grade mastic, used as a base for laying-up cold process flashing membrane where fast setting adhesives are required.
- E. Sealants: A single component, high performance, elastomeric sealant conforming to ASTM D232 or ASTM C920 requirements. Acceptable types are as follows:
1. Sonolastic NP 1 manufactured by Sonneborn Building Products; Minneapolis, MN (612) 835-3434
- D. Ceramic Granules: No. 11 Grade Specification Ceramic granules of color scheme matching the granule surfacing of the finish ply.
- E. Walkpads / Protection Pads: Provide cut sections of granule surfaced polyester reinforced modified bitumen sheet, such as "Dyna Tred Plus".
1. Walk pads shall have contrasting granule color from surfacing.
 2. Provide walk pads shall be installed at point of roof access, at service points of roofs mounted equipment requiring periodic maintenance.
 3. Protection pads shall have rounded corners and extend minimum four (4) inches beyond edge of overlying element.
 4. Provide new protection pads under pipe supports, at HVAC and mechanical access points, in front of roof top doors and openings.
- F. Fasteners:
1. Shall be Factory Mutual approved and as recommended by the manufacturer for the specific application.
 2. Fastener for Brick: Shall be 1/4 inch x 2 inches, stainless steel nail, one piece unit, flat head, as manufactured by Rawl Zamac Nailin, or approved equal.
 3. Fastener for Wood and Insulation (over steel decks): Shall be a minimum #14 Factory Mutual approved fastener, fluorocarbon coated, with CR-10 coating. A minimum 0.200-inch diameter shank and 0.250-inch diameter thread. To be used with Factory Mutual approved, round pressure plates or bar, and having a fluorocarbon CR-10 coating, when subjected to 30 Kesternich cycles (DIN 50018) shows less than ten percent (10%) red rust which surpasses Factory Mutual Approval Standard 4470 as manufactured by Olympic Manufacturing Group, Inc., or pre-approved equal. Stainless Steel 304 when used with ACQ treated lumber.
 4. Nails: Stainless Steel ring shank, size as required to suite application, minimum 11 gauge with 3/8-inch diameter head.
 5. Iron-Lok Toggle: Shall be a toggle bolt with minimum 0.215-inch diameter shank and minimum 20 threads per inch, with a 2-1/2 inch wingspan, with wing activated adhesive and pressure plate, as manufactured by Olympic Manufacturing Group, Inc.
- G. Liquid Flashings: One-Part Liquid Flashing is a one-component polyurethane / bitumen resin that provides a liquid flashing solution for asphaltic roofing systems. Utilize fabric in three-part system at penetrations.

2.9 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Other materials shall be as shown, specified or required and be of the best grade for the

proposed use as recommended by the manufacturer.

1. Expansion Joint: As detailed on drawings and outlined in NRCA and SMACNA manuals.
2. Low Level expansion joints, as noted on the drawings, to be fabricated similar to Situra Inc. "Red Line" Low level expansion joint details. Install as per manufactures recommendations.
 - a. Approved Substitute Soprema's "Sopra Joint". Install as per manufactures recommendations.
3. Sealant Backer Rod: Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable, non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type which will not be deteriorated by sealant application temperature as indicated.
4. Pipe Hangers and Supports: Provide and install necessary supports for gas lines, conduit, chilled water lines, duct work, condensate lines, etc. Refer to Section 07 72 00, Roof Accessories.
5. Cant Strips: Shall be wood fiber where used for non-structural purposes. Shall be treated solid wood where used for structural purposes meeting NRCA, Factory Mutual and Underwriters Laboratory guidelines. If solid wood cant is used where insulation exists, cant is to be toe nailed into treated solid wood nailer the same height as insulation.
6. Termination Bar:
 - a. Material: Extruded aluminum bar with lip profile.
 - b. Size: 0.090 inch thick by 3/4" inch wide with 3/16 inch lip width and a 45 degree lip angle, factory punched 1/4 inch x 3/8 inch oval holes spaced six (6) inches on center.
 - c. Approved Product/Manufacturer: "LIPTB 06" manufactured by Olympic Manufacturing Group, Inc., or approved equal.

PART 3 - EXECUTION

3.1 SITE CONDITIONS

- A. Environmental Requirements:
 1. Apply roofing in dry weather.
 2. Do not apply roofing when ambient temperature is below 45 degrees F.
 3. Refer to manufacturers recommendations.

3.2 ROOFING AND FLASHING - GENERAL

- A. Membrane Application: Install roofing in accordance with roofing system manufacturer's current published instructions and the following requirements. Application of roofing membrane components shall immediately follow installation of insulation as a continuous operation.
- B. Aesthetic Considerations: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this Project. Make necessary preparations, utilize recommended application techniques, apply the specified materials and exercise care in ensuring that the finished application is acceptable to the Owner.
- C. Application of materials shall be in strict accordance with the manufacturer's recommendations except where more stringent requirements are shown or specified. In

the instance of a conflict between these specifications and those of the manufacturer, the more stringent specifications shall take precedence.

D. General Installation:

1. Protect adjacent areas with tarpaulin or other durable materials.
2. Contractor shall prevent overspray, and be responsible for parking lot areas and/or adjoining areas not part of this contract.
3. Contractor shall be responsible for sealing, as required, openings that may allow bitumen migration or drippage, i.e. pitch dams, envelopes, and filler strips.
4. Prepare surfaces according to manufacturer's or applicator's published instructions. Metal that is to receive bitumen, or come in contact with bitumen or adhesive, shall be first primed with appropriate primer. Kynar 500 or Hylar 5000 finished metal shall be buff sanded on the surface which is to be primed prior to the application.
5. Use cleaning materials or primers necessary to render an acceptable surface/substrate.
6. Surfaces/substrates shall be clean and dry prior to application of materials. Roof deck substrates shall be inspected for moisture in accordance with the manufacturer's recommendations. Architect's representative shall witness inspection. Roofing installed before inspection by Architect's representative shall be removed to allow inspection.
7. Prior to application of felts and membrane, foreign matter, gravel, etc., shall be removed from the substrate. Gravel or debris between the substrate and plies is not acceptable.
8. Ambient temperature shall be 45 degrees F and rising.
9. Bitumen kettles or tankers shall have a visible thermometer and thermostatic control to provide positive monitoring of the bitumen temperature when it is heated in accordance with manufacturer's instructions. Kettle shall be kept a minimum of 20 feet away from building, placed so that fumes, odors, and smoke, do not enter building through windows, doors, fresh air vents or similar entrances; are not directed towards freshly painted or anodized surfaces, glass or other glazing materials. Do not place kettle under trees or near vegetation. The assigned kettle man shall remain in close attendance, within 25 feet of ground level, while burners are lit. Kettle lids are to remain closed except for loading. Level of bitumen shall be kept within eight (8) inches from top of kettle. Kettles are to have afterburners installed to reduce fume emissions.
10. Asphalt Bitumen Heating: Heat and apply bitumen in accordance with equiviscous temperature method ("EVT Method") as recommended by the manufacturer. Discard bitumen that has been held at temperature, exceeding finished blowing temperature (FBT) for a period exceeding three hours. Do NOT heat bitumen to a temperature higher than 25 degrees F (14 degrees C) below flash point.
11. Asphalt Temperatures: If the EVT information is not provided, the following asphalt temperature shall be observed. Maximum heating temperature shall be 525 degrees F. Minimum application temperature shall be 400 degrees F.
12. Asphalt Moppings: Ensure that moppings do not exceed a maximum of 25 pounds per square. Mopping shall be total in coverage, leaving no breaks or voids.
13. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.
14. Circulate bituminous materials, do not allow bituminous materials to stand in luggers for long periods. Use insulated hot transport lines and luggers.
15. Keep kettle lid closed except when adding bitumen.
16. Wrinkles, buckles, kinks, and fishmouths are not acceptable when laying felt and membrane.
17. Dry voids of felt on felt are not acceptable.

18. Primed cant strips shall be installed at the intersection of the deck and the vertical surfaces.
19. Flashings shall be mechanically top-fastened with a termination bar a minimum of six (6) inches on center at the top leading edge, and be a minimum of eight (8) inches in height above the finished membrane height.
20. On slopes greater than one (1) inch in 12 inches, refer to NRCA and/or manufacturer's guidelines for backnailing procedures and follow the more stringent guidelines for specified materials.
21. Correct errors in application the same work day they occur, including voids, fishmouths, dry laps or spots, wrinkles, ridges, blisters, bare spots, improper application, physical damage and work not meeting specifications.

3.3 NAILERS

- A. Wooden nailers shall be installed at perimeter edges or drip edges on outside perimeter of building in accordance with FM Global 1-49 securement requirements. Deck penetrations (soil stacks, mechanical curbs, etc.) shall receive wooden nailers stacked minimum 3/4 inch above designed deck thickness. MCA and MCQ only.
- B. Construction: Nailers shall be the same height as the finished height of the insulation layer. Nailers shall be anchored to resist a pull-out force of 175 pounds per foot. Fasteners shall be no less than two (2) per nailer, and be spaced at three (3) feet on center maximum or as required by FM Global 1-49 requirements. Provide nailers at penetrations. Install/Raise curbs, etc, a minimum of ten (10) inches above roof deck.

3.4 SUBSTRATE PREPARATION

- A. Lightweight Insulating Concrete Deck Systems: Nailable fills shall receive base sheet properly fastened with suitable FM approved fasteners and installed in accordance with ASCE 16 wind uplift pressure calculations.
 1. Damaged lightweight fill decks shall be removed back to solid material. Fill holes, bird baths, etc., in deck using Zonopatch; or equal by approved manufacturer.

3.5 APPLICATION OF BASE SHEET AT LWIC AND TECTUM DECKS

- A. Lightweight concrete and Tectum decks shall be covered with a base sheet, mechanically fastened as follows:
 1. Install in accordance with manufacturer's current published application instructions and to meet ASCE-16 wind uplift requirements. Fasteners and fastening patterns shall be determined by building height, pull out values from lightweight insulating concrete decks (more stringent applies), location and geographical area of the United States. It is the contractor's responsibility to consult current ASCE-16 publications, literature, and bulletins that are in effect at the time of this project. Submit perimeter, field and corner fastening patterns and cite ASCE-16 data pertaining to the fastening pattern to the Architect for review.

3.6 APPLICATION OF INSULATION

- A. General:
 1. Manufacturer's Instructions: In regard to attachment, the manufacturer's instructions or specifications shall determine the suitability for an application.
 2. Precautions: The surface of the insulation must not be ruptured or damaged prior to installation of the roof membrane. Replace damaged boards.

3. Thermal insulation boards shall be laid on the substrate in parallel rows with end joints staggered and butted as close as possible. Joints shall be tight and at the roof perimeter and roof penetrations, insulation shall be cut neatly and fitted to reduce openings to a minimum. Openings 1/4 inch or larger shall be filled with insulation.
 4. Insulation shall be tapered or feathered at drains and scuppers to provide proper drainage (if applicable).
 5. No more insulation shall be installed than can be covered by the completed roof system by the end of the day or the onset of inclement weather.
 6. Tapered insulation and crickets, when specified, shall be placed in accordance with the drawings and/or as required NRCA standards.
- B. (Steel decks); Specified layers of rigid insulation shall be mechanically fastened to the steel deck meeting ASCE-16 wind uplift requirements as dictated by wind zone applicable to location of project. Fasteners and fastening patterns shall be determined by building height, location and geographical area of the United States. The specified recovery board, the top surface of the underlying layer of insulation shall be adhered with roofing manufacturers low rise foam adhesive, and subsequent layers of insulation shall be applied using offset joints, so that individual insulation layers joints are offset a minimum of six inches (6") both ways with the preceding layer, and immediately walked in place. It is the contractor's responsibility to consult current publications, literature, and bulletins of current codes and the manufacturer that are in effect at the time of this project.
- C. (LWIC and Tectum decks); Layers of insulation or specified recovery board, the top surface of the underlying layer of insulation or base sheet shall be adhered with roofing manufacturers low rise foam adhesive, and subsequent layers of insulation shall be applied using offset joints, so that all individual insulation layers joints are offset a minimum of six inches (6") both ways with the preceding layer, and immediately walked in place.

3.7 ROOF MEMBRANE INSTALLATION

- A. Membrane Application: Install roofing in accordance with roofing system manufacturer's current published instructions and the following requirements. Application of roofing membrane components shall immediately follow application of insulation as a continuous operation.
- B. Aesthetic Considerations: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this Project. Make necessary preparations, utilize recommended application techniques, apply the specified materials (i.e. granules, metallic powder, etc.) and exercise care in ensuring that the finished application is acceptable to the Owner.
- C. Bitumen Consistency: Cutting or alterations of bitumen, primer, and sealants will not be permitted.
- D. Roofing Application: Apply layers of roofing free of wrinkles, creases or fishmouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets. Lap seams between the base ply layer and the finish ply layer shall not coincide. Stagger the courses to ensure this.
1. Apply layers of roofing so that water flows over or along lap seams, but never against laps.
 2. Mechanically attached and heat weld the seams or bond the base ply to the recover board with torch, hot asphalt. Each sheet shall have minimum three (3)

- inch side laps and six (6) inch end laps. Each sheet shall be applied directly behind the applicator. Stagger end laps a minimum of three (3) feet.
3. Bond the finish ply to the base ply with torch, or hot asphalt. Each sheet shall have a minimum of three (3) inch side and six (6) end laps. Each sheet shall be applied directly behind the applicator. Stagger end laps of the finish ply a minimum of three (3) feet. Stagger side laps of the finish ply a minimum of 12 inches from side laps in the underlying base ply. Stagger end laps of the finish ply a minimum of three (3) feet from end laps in the underlying base ply.
 4. Maximum sheet lengths and special fastening of the specified roof membrane system may be required at various slope increments where the roof deck slope exceeds 1/2 inch per foot. The manufacturer shall provide acceptable sheet lengths and the required fastening schedule for roofing sheet applications to applicable roof slopes.
 5. Lap Treatment: A 20-pound roller shall be used on side and end laps, following immediately behind application, apply uniform pressure across lap area to achieve a continuous visible bleed out.
- E. Granule Embedment: Broadcast mineral granules over bitumen overruns on the finish ply surface, while the bitumen is still hot, to ensure a monolithic color and adhesion.

3.8 ROOF FLASHING MEMBRANE INSTALLATION

- A. Flashing - General:
1. Flashings shall be installed using the manufacturer's flashing membrane, with length of run not to exceed manufacturer's recommendations.
 2. Wooden nailers or curbs shall be installed at edges and openings in the roof, mechanically fastened to the deck. The nailers should be of exterior grade wolmanized timber, and of the same thickness as any insulation to be used on the roof.
 3. Cant strips shall be installed at the intersection of the deck and/or vertical surfaces. Prime cants.
 4. The roofing field membrane shall extend up over and to the top of cant strips at vertical intersections or out to the roof's edge.
 5. Substrates receiving flashing membrane shall be clean and primed with asphalt primer, prior to application.
 6. Flashings shall be mechanically fastened with a termination bar a maximum of six (6) inches on center, be a minimum of eight (8) inches above finished roof height (seal top with three (3) coursing), extend a minimum of nine (9) inches onto the field of horizontal roof membrane, and not exceed ten (10) linear feet of run in length.
 7. Install flashing membrane in accordance with drawings and/or material manufacturer's guarantee requirements, whichever is the most stringent.
 8. Exert sufficient pressure on the flashing membrane to ensure the prevention of air pockets. This can be accomplished by using a damp, kitchen type sponge mop or a damp, heavy duty cotton nap paint roller.
 9. Prime end laps of the flashing membrane with a uniform coating of the specified asphalt primer and allow to thoroughly dry prior to overlapping of adjoining sheets.
 10. Probe laps using a clean, heated roofing trowel and heat fuse dry laps of the flashing membrane to ensure a complete seal.
- B. Flashing Application - Masonry Surfaces: Flash masonry parapet walls and curbs using the reinforcing sheet and the metal foil flashing membrane. After the base ply has been applied to the top of the cant, adhere the reinforcing sheet, utilizing minimum three (3) inch side laps and extend a minimum of three (3) inches onto the base ply surface and

three (3) inches up the parapet wall above the cant. After the final roofing ply has been applied to the top of the cant, prepare the surface area that is to receive flashing coverage by torch heating granular surfaces or by application of asphalt primer; allowing primer to dry thoroughly. Torch apply the metal foil-faced flashing into place using three (3) foot widths (cut off the end of roll) always lapping the factory selvage edge. Stagger the laps of the metal foil flashing layer from lap seams in the reinforcing layer. Extend the flashing sheet a minimum of four (4) inches beyond the toe of the cant onto the prepared surface of the finished roof and up the wall to the desired flashing height. Exert pressure on the flashing sheet during application to ensure complete contact with the wall/roof surfaces, preventing air pockets; this can be accomplished by using a damp sponge or shop rag. Check and seal loose laps and edges. Nail the top edge of the flashing on nine (9) inch centers. (See manufacturer's schematic for visual interpretation.)

- C. Flashing Application - Wood Surfaces: Flash wood or plywood parapet walls and curbs using the reinforcing sheet and metal foil flashing membrane. The reinforcing sheet shall have minimum three (3) inch side laps and extend a minimum of three (3) inches onto the base ply surface and to the top of the parapet wall, curb, etc. Nail the reinforcing sheet through the field of the sheet to the vertical wood surface on 12 inch centers from the top of the cant to top of wall curb, etc. Adhere the remainder of flashing reinforcing sheet that extends over the cant and roof level. After the finish ply has been applied to the top of the cant, prepare the surface area that is to receive flashing coverage by torch heating granular surfaces or application of asphalt primer; allowing primer to dry thoroughly. Torch apply the metal foil-faced flashing into place using three (3) foot widths (cut off the end of roll) always lapping the factory selvage edge. Extend the flashing sheet a minimum of four (4) inches beyond the toe of the cant onto the prepared surface of the finished roof and up the wall to the desired flashing height. Exert pressure on the flashing sheet during application to ensure complete contact with the wall/roof surfaces, preventing air pockets; this can be accomplished by using a damp sponge or shop rag. Check and seal loose laps and edges. Nail the top edge of the flashing on nine (9) inch centers. (See manufacturer's schematic for visual interpretation.)
- D. Projection Flashings:
1. Plumbing Vents: Soil vent stack pipes shall receive lead flashings installed in accordance with practices set forth in the NRCA Roofing Manual. The lead shall be carried up and over the top of the stack and crimped down into the pipe to form a watertight seal. Projections shall be flashed as recommended by the roof membrane manufacturer. Strip-in flange with specified stripping ply and cap with finish ply. Provide flashing membrane target.
 2. Square Projections: Strip in flanges on square projections with specified stripping ply and cap with finish ply. Provide flashing membrane target. Provide tapered edge strips around base. Cricket up-side slope.
 3. Prime flanges prior to setting in a bed of mastic. Install to manufacturer's specifications. Provide tapered edge strips around base as required. Cricket up-side slope.
 4. Round Projections: Strip in flanges on round projections with specified stripping ply and cap with finish ply. Provide flashing membrane target.
 5. Prime metal prior to setting in mastic. Install to manufacturer's specifications.
- E. Wall and Curb Flashings:
1. The flashing substrate shall be free of dirt and loose material.
 2. $\frac{3}{4}$ " plywood is to be used at parapets that receive wall flashings.
 3. The underlayment ply or plies shall be brought to the top of the cant strip and adhered.

4. Starting on the roof at least six (6) inches from the roofside edge of the cant strip, adhere two (2) plies of flashing extending over the cant and up the vertical a minimum of eight (8) inches. Each lap of the ply sheet shall be a minimum of three (3) inches.
5. Starting two (2) inches past the flashing plies, install one (1) ply of SBS flashing membrane in hot asphalt. Laps shall not coincide with previously installed plies. The top of the SBS flashing shall be one (1) inch past the previously installed plies above the cant strip.
6. Fasten the top edge of the flashings on six (6) inch centers using approved termination bar and fasteners.
7. An NRCA-approved metal counterflashing shall extend down over the flashing a minimum of four (4) inches.
8. Cricket the up-side slope at curb projections.

F. Perimeter Edge Flashing: Refer to Section 07 62 00.

3.9 OVERNIGHT SEAL / WATER CUT-OFF

- A. Over Night Seal: Shall be performed according to accepted roofing practice as outlined in the NRCA Roofing Manual.
- B. Water Cut-Off: At the end of day's work or when precipitation is imminent, construct a water cut-off at open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to resumption of roofing.

3.10 ROOF SYSTEM INTERFACE WITH RELATED COMPONENTS

- A. The following is a list of descriptions for correct installation of components integrated into the roof membrane assembly. In all cases, unless otherwise approved, incorporate flanged components into the system between the application of the base ply and finish ply. The flange must be primed with a uniform coating of approved ASTM D41 asphalt primer and allowed to dry thoroughly; flanges must be set in approved mastic.
- B. Sealant: Caulk exposed finish ply edges at gravel stops, waste stacks, pitch pans, vent stacks, etc., with a smooth continuous bead of approved sealant as required.
- C. Sheet Metal: Refer to Section 07 62 00, ROOF RELATED SHEET METAL.

3.11 FIELD QUALITY CONTROL AND INSPECTIONS

- A. Roof cuts shall be performed and repaired at contractor's expense. Cuts shall be made in the areas as indicated by the Architect's representative. Send required roof cuts to roof membrane manufacturer for laboratory examination. Roof cuts required by the Architect's representative shall be furnished to the Architect's representative for testing.
- B. Remove not more than one (1) 12-inch x 12 inch cut per 5,000 square feet of roof area or fraction thereof.
- C. Field audit will follow criteria outlined in current roof membrane manufacturer's Reference Manual.

PART 1 - GENERAL CONDITIONS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Providing coordination for the entire roofing assembly, including, but not limited to:
 - 1. Tapered edge strips, cant strips, and wood nailers. (Refer to this Section and Section 06 10 00)
 - 2. Modified bitumen membrane roofing
 - 3. Flashings, including sheet metal perimeter edge (fascia) (Refer this Section and Section 07 62 00).
 - 4. Work incidental to, the complete and proper installation of a watertight modified bitumen membrane roofing system as shown on the drawings or specified herein, and in accordance with all applicable requirements of the Contract Documents.
- B. It is the intent of this Section that the Work shall:
 - 1. provide a watertight facility.
 - 2. conform to all applicable building code requirements and of authorities having jurisdiction.
 - 3. include Section 07 62 00, Roof Related Sheet Metal as part of the Work of this Section; and be performed to obtain a single responsibility total system warranty.
- C. Work and materials hereinafter specified shall be best of kind described and, unless specified otherwise, shall be new and of best quality. All roofing materials utilized in performance of each type of work shall be the products of one (1) manufacturer or supplier.

1.3 RELATED WORK

- A. All Sections of Work relating to the roofing system, including mechanical, plumbing and electrical items penetrating the roof system.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. C920, Standard Specification for Elastomeric Joint Sealants
 - 2. D41, Standard Specification for Asphalt Primer Used in Roofing, Damproofing, and Waterproofing
 - 3. D312, Standard Specification for Asphalt Used in Roofing
 - 4. D2178, Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
 - 5. D4479, Standard Specification for Asphalt Roof Coatings - Asbestos-Free
 - 6. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free
 - 7. D4601, Standard Specification for Asphalt-Coated Glass Fiber Sheet Used in Roofing
 - 8. D5147, Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material
 - 9. D4897, Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
 - 10. D6163, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements

- B. ASCE-16 Wind uplifts requirements for geographical area.
- C. Federal Specifications (FS)
 - 1. SS-R-620B
 - 2. TT-S-00230C
- D. National Roofing Contractors Association (NRCA)
 - 1. Roofing and Waterproofing Manual
- E. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual
- F. International Building Code
- G. Underwriters' Laboratories (UL)
 - 1. Fire Hazards Classifications

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's printed instructions, schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, fastener pattern layout, and accessories to be used in the Work.
- B. Certifications:
 - 1. Manufacturer's written certification that installer is approved and licensed to install specified roofing system.
 - 2. Manufacturer's affidavit that materials used in Project contain no asbestos.
 - 3. Installer shall submit resume and project experience list for proposed system for Project Manager and job site superintendent.
 - 4. Installer shall submit written certification that there are no undocumented workers being employed by them or by any subcontractor on this project and that all workers on this project are covered by workmen's compensation.
 - 5. Installer shall submit list of all subcontractors with evidence of subcontractor's insurance coverage in compliance with contract requirements.
 - 6. Manufacturer's written certification of approval / acceptance of these specifications and details.
 - 7. Warranty: Submit letter from manufacturer signed by agent authorized to do so, stating acceptance of warranty as specified and detailed.
- C. Referenced Standards: Two (2) copies of each referenced standard and retain approved copies at site.
- D. Shop Drawings: Furnish from copies of the manufacturer's literature or from copies of NRCA "Roofing and Waterproofing Manual," fourth edition.
 - 1. Furnish for approval any proposed details which differ from those included with this proposal package. All proposed details shall first be approved in writing by roofing manufacturers prior to submitting them to Architect for approval.
 - 2. Furnish detail project sequencing, staging, material loading, manpower plans, and project construction schedule for approval.
- E. Samples:
 - 1. Submit sample copy of job specific warranty that is to be issued upon project completion.
 - 2. Submit mock-up of all fabricated sheet metal items.
 - 3. Submit 12-inch x 12-inch sample of all types of roof membranes to be installed.

- F. Temperature Charts: Bitumen heating devices 24-hour temperature charts.
- G. Test Reports: Bitumen manufacturer's test reports relating to the following for each batch of bitumen furnished:
 - 1. Softening Point: ASTM D312.
 - 2. Flashpoint: ASTM D92.
 - 3. Acceptable Bitumen Temperature: As recommended by the bitumen manufacturer and EVT label on containers.
 - 4. Thermometers: Two (2) handheld, "8F" thermometers complying with ASTM E1 to Architect for his checking kettle temperature.
- H. Upon Substantial Completion of Work, submit the following to Architect for his submission to Owner:
 - 1. Manufacturer's Warranty: Manufacturer's written warranty as specified.
 - 2. Maintenance Procedures: Three (3) copies of manufacturer's printed instructions for Owner's use regarding care and maintenance of roof.

1.6 PROJECT CONDITIONS

- A. Weather Condition Limitations: Proceed with roofing work when existing and forecasted weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements. Roofing applications with moisture present will not be accepted. Do not attempt construction of the roofing system when the reported temperature or calculated dew point are within three (3) degrees of each other.
- B. Do not allow waste products, petroleum, grease, oil solvents, mineral oil, and other contaminants to come into contact with the roofing system before or during installation. Advise Owner if there is a possibility of his facility emitting such contaminants in the future.

1.7 INSPECTIONS / TESTS

- A. The Architect's and Manufacturer's representative shall at all times have access to the job site and work areas. The contractor will provide proper and safe facilities for such access and inspection.
 - 1. Architect Inspections: The Architect will be providing periodic inspections throughout the duration of the project. Architect's Representative shall be required to inspect after completion of each major phase of construction for approval.
 - 2. Manufacturer Inspections:
 - a. An inspection shall be made by a representative of the material manufacturer at appropriate intervals during performance of Work to ensure that said project is installed in accordance with the manufacturer's specifications and illustrated details. Written reports by the manufacturer shall be turned over to the Architect, on each Monday following the prior week.
 - b. The authorized material manufacturer's field representative shall be responsible for:
 - 1) Keeping the Architect's representative informed after periodic inspections as to the progress and quality of the work observed.
 - 2) Calling to the attention of the contractor those matters observed which are considered to be in violation of the contract requirements.
 - 3) Reporting to the Architect's representative, in writing, any failure or refusal of the contractor to correct unacceptable practices called to his attention.
 - 4) Confirming, after completion of the work and based on his observation and test, that he has observed no application procedures in conflict with these specifications.

- B. Any failure by the Architect's or Manufacturer's Representative to detect, pinpoint, or object to any defect or noncompliance of these specifications of work in progress or completed work shall not relieve the contractor, or reduce, or in any way limit his responsibility of full performance of work required of him under these specifications.
- C. Architects may require tests and inspections as necessary to verify quality of roofing materials and workmanship. Laboratory tests will be performed in accordance with ASTM standard procedures.
 - 1. Owner will select testing laboratory and will pay for Work required by testing laboratory.
 - 2. Re-tests for work which fail initial tests or inspections shall be paid by contractor.
 - 3. Noncompliance with contractor requirements will result in the Architect/Owner to assign full-time quality control and will be subject to reimbursement by the construction manager/contractor.

1.8 QUALITY ASSURANCE

- A. Applicator:
 - 1. Applicator shall have approval by manufacturer of accepted roofing system for application and issuance of specified warranty for a minimum of three (3) years. Proof of license agreement dated at least three years prior to date of bid opening.
 - 2. Applicator shall be an experienced single firm specializing in the type of roofing and sheet metal work specified, with a minimum of five (5) years of previous successful experience on projects similar in size and scope.
 - 3. No subcontracting of sheet metal fabrication or installation will be accepted. Contractor must have a sheet metal shop on the company premises.
 - 4. Applicators shall have a competent Superintendent, who is not actually performing roofing work, on site at all time while work is in progress, with full authority to act on behalf of the Contractor as his agent.
 - 5. All workmen shall be covered by Workmen's Compensation insurance (verify upon request) and thoroughly experienced in the particular class of work upon which employed. Use of undocumented workers will not be tolerated - No Exceptions.
 - 6. Contractor shall ensure that base fastener pull out resistance tests on existing decks were performed and approved by Architect and coordinated with Roofing Consultant prior to starting roofing application.
 - 7. Roofing contractors must have reached the highest level of qualifications from the manufacturer they are providing material for (i.e. Master Select contractor).
- B. Regulatory Requirements:
 - 1. Classification by Underwriters' Laboratories, Inc. as a Class A roof covering.
 - 2. Roofing systems shall be installed in accordance with ASCE-16 wind uplift requirements for geographical location exposure C, 140 MPH 3-second gust wind speed zone and risk category II based on IBC building code requirements. Wind-resistance loads listed below have a safety factor of 2.0 incorporated into the calculation.
 - 3. Follow local, state, and federal regulations of safety standards and codes. Refer to applicable building code or International Building Code for roofing system installation requirements and limitations.
 - 1. Zone 1 Interior 68.4 psf or as otherwise indicated.
 - 2. Zone 2e Edge 91.6 psf or as otherwise indicated.
 - 3. Zone 2r Roof 119.4 psf or as otherwise indicated.
 - 4. Zone 3 Corner 92.1 psf or as otherwise indicated.
- C. Texas State Board of Insurance Windstorm Regulations: Owner will provide inspector to meet all requirements. Contractors to coordinate all applicable roof inspections with Owners Inspector.
- D. Laboratory Testing and Samples:

1. Architect may require tests and inspections as necessary to verify quality of roofing materials and workmanship. Laboratory tests will be performed in accordance with ASTM procedures.
2. Owner will select testing laboratory and will pay for Work required by testing laboratory. Contractor shall assume all costs for extraction and patch of all samples.
3. Re-tests for work which fail initial tests or contractor shall pay inspections.
4. Contractor shall correct all deficiencies in accordance with manufacturers recommended procedures at no cost to Owner.

E. Installation:

1. Unless otherwise indicated, the materials to be used in this specification are those specified and denote the type, quality, performance, etc. required. All proposals shall be based upon the use of the specified material.
2. Install materials in accordance with the manufacturer's current published application procedures and the general recommendations of the National Roofing Contractor's Association.
3. It will be the contractor's responsibility to obtain and/or verify any necessary dimensions by visiting the job site, and the contractor shall be responsible for the correctness of it. Any drawings supplied are for reference only.
4. Contractor shall plan and conduct the operations of the work so that each section started on one day is complete, details installed and thoroughly protected and in watertight condition before the close of work for that day.
5. Materials will be securely fastened in place in a watertight, neat and workmanlike manner. All workmen shall be thoroughly experienced in the particular class of work upon which employed. Work shall be performed in accordance with these specifications and shall meet the approval in the field of the Architect.
6. All waste materials, rubbish, etc., shall be removed from the Owner's premises as accumulated. Rubbish shall be carefully handled to reduce the spread of dust and shall be deposited at an approved disposal site. At completion, all work areas shall be left broom clean, and all contractors' equipment and materials removed from the site.

1.9 PERFORMANCE REQUIREMENTS

- A. Texas State Board of Insurance Windstorm Regulations: Owner will provide inspector to meet all requirements. Contractors to coordinate all applicable roof inspections with Owners Inspector.
- B. Fire Resistance: Meet Underwriter's Laboratory Class "A" fire rating.
- C. Contractor shall ensure that base fastener pull out resistance tests on new lightweight insulating concrete fill were performed and approved by Architect and coordinated with Roofing Consultant prior to starting roofing application.

1.10 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 00 – Project Management and Coordination.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original unopened packaging with all tags and labels intact and legible. Carton and can labels shall indicate appropriate warnings, storage conditions, lot numbers, and usage instructions. Handle and store materials and equipment in such a manner as to avoid damage. Coordinate material storage with school Principal.
- B. Manufacturer's packaging and / or roll plastic is not acceptable for exterior storage. Tarpaulin with grommets shall be minimum acceptable for exterior coverings. All materials

stored as above shall be minimum of four (4) inches off the substrate, and the tarpaulin tied off with rope.

- C. Products liable to degrade as a result of being frozen shall be maintained above 40 degrees F in heated storage.
- D. Moisture sensitive products shall be maintained in dry storage areas or properly covered. Roofing insulation and felts must always be covered or stored in a dry area when not being used.
- E. The proper storage of materials is the sole responsibility of the contractor. Materials damaged in shipping or storage shall not be used. Wet or damaged roofing materials shall be discarded, removed from job site, and replaced with new materials prior to application.
- F. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

1.12 PRECAUTIONS

- A. Some of the indicated materials are extremely flammable and/or toxic. Use precautions indicated on can and carton labels.
- B. Due caution should be exercised so as not to alter the structural integrity of the deck. When cutting through any deck, care should be taken so as not to damage the deck or any part of the deck, such as post tension cables, etc.
- C. If torches are used, Contractor shall maintain a three (3) hour fire watch after completion of torching of each day's work. Provide a 20 lb. fire extinguisher near torch at all times. Use a thermal infrared thermometer to monitor all roof areas.
- D. The contractor is to verify the location of all interior ducts, electrical lines, piping, conduit, and/or similar obstructions. The contractor is to perform all work in such a manner as to avoid contact with the above-mentioned items.

1.13 WARRANTY

- A. Roofing Manufacturer: Warrant the roofing and associated Work for 20 years from date of Substantial Completion as follows:
 - 1. The warranty shall be a NDL "No Dollar Limit" / no penal sum type, with total replacement cost.
 - 2. The warranty shall guarantee the entire roof system and associated work against defective materials and workmanship of installation, with NO exclusion for ponding water.
 - 3. The roof system shall include roof insulation, flashing, metal work, labor, and materials shall be guaranteed against failure of workmanship and materials. Repair of the system, including materials and labor, shall be done at no cost to the Owner.
- B. Roofing Contractor: Jointly with any subcontractors employed by him, shall guarantee the work required and performed under this contract will be free from defects in workmanship and materials, and that the building will be and remain waterproof for a five (5) year warranty period, after the Architect accepts the work as substantially complete. The warranty shall be in approved notarized written form, to obligate the Contractor, and subcontractors, to make good the requirements of the warranty. The warranty will be held jointly with the Bonding Company for the first two (2) years and the manufacturer for the remaining three (3) years.

- C. Make arrangements with the materials manufacturer to provide required inspections for issuance of warranty. Final warranty shall be submitted to Owner at time of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Components of the roof system shall be products of a single manufacturer as indicated on the Detail Drawings and specified in the Contract Documents.
- B. Components that are other than those supplied by manufacturer may be submitted for review and accepted. Acceptance of any other product is only for a determination of compatibility with products. The specifications, installation instructions, limitations, and restrictions of the respective manufacturers must be reviewed by the Owner's Representative for acceptability for the intended use with products.

2.2 APPROVED PRODUCTS/MANUFACTURERS

- A. Unless noted otherwise, specifications are based on products of named manufacturers but should not preclude the Contractor from using other manufacturers who produce products that meet or exceed the specifications. Manufacturers whose products meet or exceed the specifications, who have manufactured and installed roof materials and systems of the type specified for a minimum of ten (10) years, and who maintain a single source responsibility for the total roofing system, as described herein, may apply for approval as a substitution in accordance with Division 1 requirements regarding substitutions.
1. All materials shall be manufactured, specified, or accepted in writing by membrane manufacturer issuing the warranty. Proposed materials shall ensure full system warranty from said manufacturer. Installer shall be an applicator licensed by the manufacturer.
 2. Samples of all materials used on the project, which are not supplied by the membrane manufacturer, shall be submitted to the membrane manufacturer for written approval prior to starting work.
 3. All materials used on the project shall be asbestos free.
- B. Approved Manufactures:
1. Sika Sarnafil, Lyndhurst, NJ,(800)-451-2504
 2. GAF, Parsippany, NJ,(973) 628-3000
 3. Siplast, Inc., Irving, Texas, (972) 869-0070
- C. Membrane shall conform to:
1. ASTM D-4434 (latest version), "Standard for Polyvinyl Chloride Sheet Roofing". Classification: Type II.
 2. NSF/ANSI Standard 347, "Sustainability Assessment for Single Ply Roofing Membranes". Certification Level: Platinum.
 3. The manufacture guarantees that the membrane thickness meets or exceeds the specified thickness when tested according to ASTM D-751.
- A. PVC Sheet: Basis of Design Sika Sarnafil 60 mil. G410 Feltback with Décor Rib .
1. Approved Product:
 1. Sika Sarnafil Product: G410- PVC- Feltback
 2. GAF Product: Everguard-PVC-Fleeceback
 3. Siplast Product: Parasolo PVC-Fleeceback
 4. Guaranteed Membrane Thickness
 - a) 60 mil minimum

Color of Membrane

1. Patina Green

2.02 INSULATIONS / ROOF BOARDS

A. Flute Fill Insulation

1. 2.25" Rigid polyisocyanurate insulation board with coated polymer bonded glass fiber mat facers, meeting ASTM C-1289 Type II, Class 2, Grade 3.

B Cover Board

1. DensDeck® Prime Roof Board
 - a. ¾" Gypsum roof board with fiberglass mat facers primed on one side, meeting ASTM C-1177.

2.03 ATTACHMENT COMPONENTS

A. Membrane Adhesive- Bonding Adhesive: As recommended by Thermoplastic Sheet Manufacturer's printed instructions to develop a bond between the membrane and the substrate to which the membrane is to be attached. Manufacturer's Bonding Adhesive or approved substitute.

B. Solvent-based for use with felt back membranes, VOC compliant, reactivating adhesive used to attach membrane. Sarnacol 2170 VC Adhesive.

C. Feltback Membrane Adhesive

Two-component foamable polyurethane board adhesives applied in ribbons used to attach feltback membrane.

A. Insulation / Roof Board Adhesive

1. Two-component foamable polyurethane board adhesive applied in ribbons or full applications. No temperature restrictions. Sarnacol 2163
2. Two-component foamable polyurethane board adhesive applied in ribbons or full applications. The minimum ambient and surface temperature required is 25°F (-4°C) and rising. Sarnacol AD Board Adhesive
3. Adhesive (canister version)
Two-component foamable polyurethane board adhesive applied in ribbons or full applications used to attach insulation and roof boards.

B. Insulation / Roof Board Attachment

- A. Fasteners:** FM Approved corrosion resistant steel screws of the appropriate size for fasteners for roof membrane and insulation attachment and for sheet metal flashing. Fasteners for the membrane shall be supplied by the Thermoplastic Manufacturer and are to be installed as recommended by Thermoplastic Sheet Manufacturer's printed instructions.
- B.** Shall be Factory Mutual approved and supplied by the manufacturer for the specific application.
- C. Fastener for Brick:** Shall be 1/4-inch x 2 inches, stainless steel nail, one piece unit, flat head, as manufactured by Rawl Zamac Nailin, or approved equal.
- D. Fastener for Wood and Metal Deck:** Shall be a minimum #14 Factory Mutual approved fastener, fluorocarbon coated, with CR-10 coating. A minimum 0.200-inch diameter shank and 0.250 inch diameter thread. To be used with Factory Mutual approved, round pressure plates or bar, and having a fluorocarbon CR-10 coating, when subjected to 30 Kesternich cycles (DIN 50018) shows

less than ten percent (10%) red rust which surpasses Factory Mutual Approval Standard 4470 as manufactured by Olympic Manufacturing Group, Inc., or pre-approved equal.

- E. Nails: G-90 galvanized or non-ferrous type, size as required to suit application, minimum 11 gauge with 3/8-inch diameter head.
- F. Low Profile Plate:
 - 22 gauge, 2-3/4" (70 mm) square steel plate with a Galvalume coating, used with #12, #14, and #15 Sarnafasteners to attach Sarnatherm insulation, Sarnatherm roof boards, gypsum roof boards, or other approved boards to the roof deck. Sarnaplate Low Profile
- G. Fastener:
 - #12 corrosion-resistant fastener used with Sarnaplates to attach Sarnatherm insulation, Sarnatherm roof boards, gypsum roof boards, or other approved boards to the roof deck. Sarna fastener #12

2.04 FLASHING MATERIALS

- A. Flashing and Flashing Accessories: As recommended by the Thermoplastic sheet Manufacturer's printed instructions for reinforced sheet flashing of same material, type, thickness, and color as sheet membrane.

Perimeter Edge Flashing

- 1.
 - 24 gauge, G90 galvanized steel with PVC-coating on one side for heat-weldability. shop fabricated to meet project requirements.

Miscellaneous Flashing

- 1. Round circle patch.
- 2. Injection molded inside corner.
- 3. Injection molded outside corner.
- 4. Injection molded stack/pipe boot to flash pipes, vent stacks and cylindrical penetrations.
- 5. Prefabricated stack/pipe boot open along one side to flash pipes, vent stacks and cylindrical penetrations when access is obstructed.

2.05 MISCELLANEOUS ACCESSORIES

- A. General: Furnish auxiliary materials recommended by Roofing System Manufacturer for intended use and compatible with membrane roofing materials.
- B. Flashing and Flashing Accessories: As recommended by the Thermoplastic sheet Manufacturer's printed instructions for reinforced sheet flashing of same material, type, thickness, and color as sheet membrane.
- C. Metal Termination Bars: Manufacturer's standard aluminum bars, 1-inch (25-mm) wide, roll formed and pre-punched.
- D. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, pre-punched.

- E. Metal Flashings, Copings, Edge Trim and Accessories: Provide all roofing Manufacturer's metal required for a complete roofing system covered under the Manufacturer's warranty.
- F. Sealants: Membrane Manufacturer's approved sealant shall be used to seal penetrations through the membrane system and at miscellaneous sealant applications that come in contact with roof systems components.
- G. Air Seal Membrane: If required by manufacturer to meet wind design requirements. Air seal membrane shall be a minimum of 4 mil. Polyethylene sheeting or as required by roof system manufacturer.
- H. Liquid Flashings: One-Part Liquid Flashing is a one-component polyurethane / bitumen resin that provides a liquid flashing solution for thermoplastic roofing systems. Utilize fabric in three part system at all penetrations.
- I. Walkpads / Protection Pads: Provide a polyester reinforced, weldable membrane with embossment like a chevron pattern.
 - 1. Protection pads shall have rounded corners and extend minimum four (4) inches beyond edge of overlying element.
 - 2. Provide new protection pads under all pipe supports, at HVAC and mechanical access points, in front of all roof top doors and openings.
- J. Miscellaneous Accessories: Provide pourable sealants, performed cone and vent sheet flashings, pre-formed inside and outside corner sheet flashings, T-joint covers, termination reglets, and other accessories as recommended by Roof System Manufacturer for intended use.
- K. Other miscellaneous materials shall be of the best grade available and approved in writing by Roof System Manufacturer, prior to use, for specific application.
- L. Décor Profile Rib: PVC extruded rib hot air welded to the membrane to simulate the look of a standing seam metal roof.
- M. Membrane Cleaner: to clean roof

2.06 SEALANTS AND PITCH POCKET FILLERS

- A. Moisture-cured, one-component polyurethane-based, non-sag elastomeric sealant used in wall, curb and drain terminations. It is also used as a sealant at pipe penetrations and under certain metal flashings. Sikaflex-1a can be used as a pourable sealer pocket filler.

2.07 MISCELLANEOUS FASTENERS AND ANCHORS

All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum, or stainless steel. Mixed metal type components shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins.

2.08 RELATED MATERIALS

- A. Nailers, cants and wooden curbs shall be No. 2 or better treated lumber selected to meet design details and field dimensions and requirements of Section 06 10 00, Rough Carpentry. MCQ and MCA only.
- B. Plywood-When bonding directly to plywood, a minimum 3/4" (13 mm) CDX (C side out), smooth-surfaced exterior grade plywood with exterior grade glue shall be used. Rough-surfaced plywood

or high fastener heads will require the use of Sarnafelt behind the flashing membrane. Plywood shall have a maximum moisture content of 19% by weight on a dry weight basis.

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

- A. Existing Conditions: Examine existing building and new construction to determine existing physical conditions that affect installation of new roofing.
- B. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to Manufacturer's written instructions and warranty requirements.
- C. Environmental Requirements:
 - 1. Apply roofing in dry weather.
 - 2. Do not expose roof components and flashing in inclement weather or when it is predicted 30% or more possibility for inclement weather.
 - 3. When ambient temperature is below 40 degrees Fahrenheit, expose only enough sensitive cements, sealants, and adhesives as required for use within a four-hour period.
 - 4. Do not expose membrane and accessories to a constant temperature of 180 degrees Fahrenheit.
- D. Protection:
 - 1. Provide special protection and avoid traffic on completed areas of membrane installation.
 - 2. Restore to original condition or replace work or materials damaged during handling of roof materials.
 - 3. Take precautions as required to protect adjacent work and structures.
- E. Emergency Equipment: Maintain on site equipment necessary to apply emergency temporary edge seal in event of sudden storms or inclement weather.
- F. Restrictions:
 - 1. Comply with General Requirements on use of site.
 - 2. Smoking is prohibited on all roof areas or in existing buildings.
 - 3. Maintain facility and all utility services in a functional condition.
 - 4. Provide sanitary facilities for employees.

3.2 EXAMINATION

- A. Examine and verify that receiving substrate surfaces of the structure have no defects or errors, which would result in poor or potentially defective application or cause latent defects in workmanship.
 - 1. Examine substrate to which roofing material is to be applied to ensure that its condition is satisfactory for roofing application. Do not permit voids greater than 1/4 inch wide in the substrate. Substrates for roofing materials shall be dry and free of oil, dirt, grease, sharp edges, and debris. Inspect substrates, and correct defects before application of thermoplastic sheets.
- B. Verify that roofing openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.
- C. Do not proceed with installation until unsatisfactory conditions have been corrected. Starting installation shall imply acceptance of surfaces and conditions.

3.3 NAILERS

A. Wooden nailers shall be installed at perimeter edges or drip edges on outside perimeter of building.

B. All Construction: Nailers shall be the same height as the insulation being installed or to existing raised roof edge whichever is applicable. Nailers shall be anchored to resist a pullout force of 300 pounds per linear foot per Factory Mutual Data Sheet 1-49. Fasteners shall be no less than two (2) per nailer and be spaced at two (2) feet on center maximum. Provide nailers at all penetrations. Raise all curbs, flashing, etc, a minimum of eight (8) inches above the deck.

3.4 SUBSTRATE PREPARATION

- A. Substrate Surface: Prepare substrate surfaces to ensure proper and adequate installation, in strict accordance with the Contract Documents and approved Shop Drawings, or manufacturer's requirements.
- B. Fill all gaps and voids between substrate components that are wider than 1/4 inch. Fill all gaps with same materials as the substrate.
- C. The membrane manufacturer shall specify types of substrates that are suitable for use with the bonding adhesive.
- D. Protection of Adjacent Areas or Surfaces: Protect adjacent areas or surfaces from damage as a result of the Work of this section. Remove sharp projections.
- E. 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.
- F. 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.

3.5 APPLICATION OF INSULATION

- A. General: (As required per roof area)
 - 1. Manufacturer's Instructions: In regard to attachment, the Manufacturer's instructions or specifications shall determine the suitability for an application.
 - 2. Fastener pull out test will be required for verification of condition of the metal decking and suitability of Manufacturer's metal fasteners.
 - 3. Precautions: The surface of the insulation must not be ruptured due to overdriving of fasteners. The surface of the insulation or substrate shall be inspected prior to installation of the thermoplastic roof membrane. The substrate shall be clean, dry and smooth with no excessive surface roughness, contaminated surfaces or unsound surfaces such as broken, delaminated, or damaged insulation boards. Any wet, broken, delaminated, or damaged insulation shall be replaced with new insulation.
 - 4. Thermal insulation boards shall be laid on the substrate in parallel rows with end joints staggered minimum 24" vertically and horizontally and butted as close as possible. All joints shall be tight and at the roof perimeter and roof penetrations, insulation shall be cut neatly and fitted to reduce openings to a minimum. All openings 1/4 inch or larger shall be filled with insulation.
 - 5. No more insulation shall be installed than can be covered by the completed roof system by the end of the day or the onset of inclement weather.
 - 6. Tapered insulation and crickets, when specified, shall be placed in accordance with the drawings and / or as required NRCA standards.

- B. Specified polyisocyanurate insulation shall be mechanically attached to metal deck meeting Factory Mutual recommendations for wind uplift as dictated by wind zone applicable to location of project. Subsequent layer of insulation and cover board shall be adhered to underlying polyisocyanurate insulation in low rise foam meeting Factory Mutual recommendations for wind uplift as dictated by wind zone applicable to location of project. Adhesive and thickness shall be determined by building height, location, and geographical area of the United States. It is the contractor's responsibility to consult current publications, literature, and bulletins of Factory Mutual and the Manufacturer that are in effect at the time of this project.
- C. Insulation shall be laid bearing on deck surface / flats. The long dimension of base insulation layer must be fully supported by the top flange of the metal deck. The edges of insulation boards must not cantilever over the flutes of the metal deck.

3.6 INSTALLATION OF MEMBRANE

- A. General: Install in strict accordance with manufacturer's latest published requirements, instructions, specifications, and details and approved shop drawings.
- B. Over the properly installed and prepared substrate, manufacturer's adhesive shall be poured out of the bucket and spread using notched $\frac{1}{4}$ " X $\frac{1}{4}$ " X $\frac{1}{4}$ " rubber squeegees. The adhesive shall be applied at a rate according to manufacturer's requirements. No adhesive is applied to the back of the fleece-backed membrane. **Do not allow adhesive to skin over or surface-dry prior to installation of fleece-backed membrane.**
- C. The roof membrane is unrolled immediately into the wet adhesive. Adjacent rolls overlap previous rolls by 3 inches. This process is repeated throughout the roof area. Immediately after application into the adhesive, each roll shall be firmly pressed into place with water filled, foam covered lawn roller by frequent rolling in two directions. **Do not allow adhesive to skin over or surface dry prior to installation of fleece-backed membrane.**
- D. Weld cover strips at all seams that do not have a factory selvage edge.

3.7 SEAM INSTALLATION

- A. Clean seam areas, overlap sheets, weld side and end laps of sheets and flashings according to Manufacturer's written instructions to ensure a watertight seam installation. Weld seam as follows:
 - 1. Weld Method: Hot Air
- B. Test lap edges with probe to verify seam weld continuity on a daily basis. Perform pull-tests of welded lap seam samples daily and install T-joint patches at all t-joint intersections of membrane and flashing seams.
- C. Repair tears, voids, and lapped seams in roofing that do not meet requirements.

3.8 FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrate according to roofing system Manufacturer's written instructions.
- B. $\frac{3}{4}$ " plywood is to be used at parapets that receive wall flashings.
- C. 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.

- D. Flash penetrations and field-formed inside and outside corners with sheet flashing as recommended by Manufacturer.
- E. Clean seam areas, overlap seams, and firmly roll flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
- F. Test lap edges with probe to verify seam weld continuity. Apply lap sealant, if required by roofing manufacturer, and seal exposed edges of sheet flashing terminations per Manufacturer's requirements.
- G. Terminate and seal top sheet flashings and mechanically anchor to substrate through termination bars.

3.9 METAL FLASHINGS, COPINGS, EDGE TRIM AND ACCESSORIES INSTALLATION

- A. General: Secure metal flashings accessories at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

3.10 SIMULATED STANDING SEAM INSTALLATION

- A. Note: Work pertaining to the installation of Décor shall only be done by Installer personnel that have completed a mandatory one day Décor installation and welding training course. Proper installation is critical to achieve the desired appearance.
- B. Simulated standing seams shall be installed parallel with roof slope where possible. Top surface of roof system membrane must be clean to obtain a proper weld for standing seam to roof system membrane and to enable positive traction for welding equipment.
- C. Unless noted otherwise on the drawing, the simulated standing seam spacing is to be 16" on center and evenly spaced so that each end is not less than ½ of the spacing.
- D. Preassemble simulated standing seams on the roof to the required length. Join individual lengths using connector and push together. Simulated standing seams should be lined up with the edge of the membrane overlap. Do not cover overlap.
- E. Check all deck membrane seams with rounded screwdriver and re-weld any inconsistencies before simulated standing seam installation.
- F. Position automatic welding machine to start the weld. Regularly check the simulated standing seam guide. **Installation of standing seams in a serpentine pattern or anything other than straight / true lines is unacceptable and will be reinstalled.** Extra attention is required during welding of standing seams to ensure that the automatic welding machine is traveling in a straight line.
- G. Heat weld a piece of colored roofing membrane over the exposed end of the simulated standing seam. Trim as required.

3.11 QUALITY CONTROL

- A. Roofing Installer: On-site evaluation of welded seams shall be made by the Contractor to locations as directed by the Owner's representative or Membrane Manufacturer's technical representative. Two-inch wide cross-section samples shall be taken three times a day minimum through completed seams. Correct welds shall display failure from shearing the membrane prior to separation of weld. The Contractor at no extra charge to the Owner shall patch each test cut. Test seam samples shall be label with location of seam cut, date of seam cut, and retain for Owner's representative or Membrane Manufacturer's technical representative for test cut inspection.

- B. Manufacturer's Quality Control Inspection: The Manufacturer's Technical Representative shall review the on-going work at a minimum of one time every 30 calendar days. All defects noted non-compliance with the Contract Documents or the recommendations of the Thermoplastic Manufacturer should be itemized in a punch list. These items must be corrected immediately by the Contractor to the satisfaction of the Owner's Representative and the thermoplastic manufacturer.

3.12 PROTECTING AND CLEANING

- A. Protect sheet membrane roofing from damage and wear during remainder of construction period.
- B. Immediately remove all spots, smears, stains, residues, adhesives, etc., from the Work of this Section and / or upon adjacent areas or surfaces, which result from the Work of this Section.
- C. Upon completion of the Work of this Section, dispose of, away from the Site, all debris, trash, containers, residue, roofing remnants, and scraps which results from the Work of this Section.
- D. 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.
- E. Overnight Seal / Water Cut-Off:
 - 1. Over Night Seal: Shall be performed according to accepted roofing practice as outlined in the NRCA Roofing Manual.
 - 2. Water Cut-Off: At the end of day's work or when precipitation is imminent, construct water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to resumption of roofing.
- F. Upon completion of all roof related construction (including MEP), peel protective film from thermoplastic membrane to not damage the membrane. Clean areas of sheet not covered by film to match.

3.13 ACCEPTANCE

- A. Prior to demobilization from the site, the Owner / Project Manager, Architect, and Installer shall review the work. All defects noted noncompliance with the Contract Document or the recommendations of the Membrane Manufacturer should be itemized in a punch list. These items must be corrected immediately by the Contractor prior to demobilization to the satisfaction of the Owner / Project Manager, and the Membrane Manufacturer.
- B. Notify Architect and Owner 48 hours in advance of the date and time of inspection.
- C. All warranties as required for the project of this specification shall be submitted for approval prior to final payment.

SECTION 07 62 00 - ROOF RELATED SHEET METAL

PART I – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. It is the intent of this Section that the Work shall:
 - 1. conform to all applicable building code requirements and of authorities having jurisdiction;
 - 2. include all shop and field formed sheet metal work shown on drawings, specified or required, including, but not limited to:
 - a. Roof penetration sleeves and hood and umbrella counterflashing
 - b. Metal counterflashing
 - c. Expansion joint
 - d. Roof drains
 - e. Scuppers
 - f. Metal perimeter edge
 - g. Gutters, Downspouts, Splash Blocks and Splash Pans
 - h. One-way roof moisture relief vents
 - i. Metal gravity vents
 - j. Metal heat exhaust vents
 - k. Sanitary vent pipes
 - l. Pipe box
 - m. Copings, trim and miscellaneous sheet metal accessories.
 - 3. be part of the Work of the Roofing System; and
 - 4. be performed by a single source contractor.

1.3 RELATED WORK

- A. Section 07 52 20 - Modified Bitumen “Cool Roof” Membrane Roofing System
- B. Section 07 54 20 – Adhered PVC Decor
- C. Section 07 72 00 – Roof Accessories
- D. All Sections of Work relating to or affecting the roofing system, including mechanical, plumbing and electrical items.

1.4 REFERENCES

- A. ASTM International (ASTM)
 - 1. A525, Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
 - 2. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
 - 3. B32, Standard Specification for Solder Metal
 - 4. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- B. ASCE 7

- C. Federal Specifications (FS)
 - 1. QQ-L-201 for lead
- D. National Association of Architectural Metal Manufacturers (NAAMM)
- E. National Roofing Contractors Association (NRCA)
 - 1. Roofing and Waterproofing Manual
- F. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual
- G. ANSI / SPRI ES-1

1.5 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Shop Drawings: Indicating sizes, configurations, details of attachment to related and adjacent work, materials, and finishes.
- C. Samples:
 - 1) Full range of finish colors for Architect's selection.
 - 2) 12 inch long sample of each specified item with approved finish.
 - 3) Provide full size mockup of all shop built assemblies.
 - 4) Documentation of Wind uplift requirements for Roof Edge for specific project location
 - a. Wind Calculator available online

1.6 QUALITY ASSURANCE

- A. Single Source Responsibility: Fabricator and installer of roof-related flashing, installer of prefabricated edge metal and accessories shall be the same as the membrane roof installer.
- B. Comply with governing codes and regulations of authorities having jurisdiction.
- C. ANSI / SPRI ES-1: Install sheet metal edge flashings and copings to comply with requirements of ANSI / SPRI ES-1 / FM 1-49 for minimum of up to 160 MPH wind speed zone and wind resistance loads.

1.7 INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13, Project Coordination.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store materials in accordance with manufacturer's instructions.
- B. Handle and store materials and equipment in such a manner as to avoid damage.

- C. No storage of materials shall be permitted on roof areas other than those materials that are to be installed the same day. Any exception must be in written form. Do not place materials or equipment in such a manner as to overload structure.

1.9 WARRANTIES

- A. Manufacturer's Product Warranty:
- 1) Manufacturer's standard 30 year Kynar 500 or Hylar 5000 Finish warranty signed by the manufacturer, with guarantee covering any failure of the fluoropolymer finish during the warranty period.
 - 2) Failure is defined to include, but not be limited to:
 - a. Deterioration of finish, such as fading, discoloring, peeling, cracking, corroding, etc.
 - 3) Wind Warranty
 - a. Non Coastal: up to 160 MPH Blow Off Resistance, 20 Year
 - 4) Correction may include repair or replacement of failed product as outlined in Warranty Documents
 - 5) Finish warranty and wind warranty shall be delivered by Roofing Contractor to Owner at the conclusion of project as part of project closeout documents.
- B. Roofing Contractor's Warranty:
1. Contractor shall warrant the installation and related work to be free from defects in workmanship and materials, and that the metal flashings will be and remain watertight and secure, for a period of five (5) years from date of Substantial Completion.
 2. Defects shall include, but not be limited to:
 - a. Leaking water on the exterior of the building, causing staining or discoloration of wall / exterior surface.
 - b. Leaking water or bitumen within building or construction.
 - c. Becoming loose from substrate / blocking.
 - d. Loose or missing parts.
 - e. Finish failure as defined above.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Metal Era, Inc., which is located at: 1600 Airport Rd.; Waukesha, WI 53188; Toll Free Tel: 800-558-2162; Tel: 262-549-6900; Fax: 800-373-9156
- B. Substitutions: Before proposal date upon roof consultant approval.
- C. Requests for substitutions will be considered in accordance with provisions of Section 012513.
- D. Manufacturers named within specification are approved for use on the Project providing:
1. their products meet or exceed the specifications;
 2. company has a minimum of five (5) years' experience manufacturing products of the type specified;
 3. products have been tested in conjunction with roofing membrane system as an assembly and as such has obtained the same approval and rating as the roofing membrane system; and
 4. products are approved for use by the roofing membrane manufacturer.

2.2 SHEET METAL MATERIALS

- A. General Requirements: Roofing sheet metal system shall have been tested in conjunction with roofing membrane system as an assembly and have the same approval and rating as the roofing membrane system.
- B. Prefinished Galvanized Sheet Steel:
 - 1. Commercial quality ASTM A527 G-90 hot-dip galvanized coating designation.
 - 2. Thickness: Except as otherwise indicated, minimum 24 gauge. SMACNA recommendations shall govern.
 - 3. Finish: Kynar 500 or Hylar 5000 in color as selected by Architect from manufacturer's full range of colors.
- C. Membrane Clad Sheet Steel:
 - 1. Commercial quality ASTM A527 with G-90 hot-dip galvanized coating designation.
 - 2. Thickness: Except as otherwise indicated, minimum 24 gauge. SMACNA recommendations shall govern.
 - 3. Finish: PVC / TPO coating as per Membrane Manufacturer's requirements.
- D. Sheet Lead:
 - 1. Comply with FS QQ-L-201, Grade B
 - a. Four (4) pound minimum for use at roof drains and soil stacks.
- E. Stainless Steel: ASTM A167, Type 302 / 304 Soft Temper, No. 2D finish. Minimum thickness 24 gauge, except as otherwise noted.

2.3 FASTENERS

- A. Same metal as flashing / sheet metal or other non-corrosive metal or as noted below.
- B. Exposed fasteners shall be self-sealing and gasketed (ZAC type) for weathertight installation.
- C. Match finish of exposed heads with material being fastened.
- D. Mechanical Fasteners:
 - 1. Nails: Ring shank, minimum 1-1/2 inches in length with 1/2 inch diameter head.
 - 2. Washers: Steel washers with bonded rubber sealing gasket.
 - 3. Screws: Self-tapping sheet metal type of stainless steel or compatible with material being fastened, with hooded integral EPDM washers (ZAC type).
 - 4. Rivets: Stainless steel and cadmium plated material, closed end type of sizes recommended by sheet metal manufacturer to suit application.
- E. Clips:
 - 1. Cleat (coping / fascia): Minimum 22 gauge, G-90 galvanized, stainless steel, or aluminum. Match material of coping / fascia and provide one (1) gauge heavier.

2.4 RELATED MATERIALS

- A. Solder: ASTM B32, alloy grade 58, 50 percent tin, 50 percent lead.
- B. Flux:
 - 1. Phosphoric acid type, manufacturer's standard.
 - a. For Use with Steel or Copper: Rosin flux

- b. For Use with Stainless Steel: Acid-chloride type flux, except use rosin flux over tinned surfaces.
- C. Underlayment:
 - 1. At expansion joints: to be used as bellow; 48 mil minimum, non-reinforced, homogeneous, waterproof, impermeable elastomeric sheeting manufactured by Nervastral, Inc. or Lexsuco.
 - 2. At wood blockings: Self-Adhered Flexible Flashing: 40-mil, rubberized asphalt adhesive reinforced flashing with a high density cross laminated polyethylene film. Provide compatible substrate primer as instructed by manufacturer and coordinate with specification 07 65 00.
- D. Adhesives: Type recommended by flashing sheet manufacturer seaming and adhesive application of flashing sheet to ensure adhesion and watertightness.
- E. Metal Accessories: Sheet metal clips, straps, anchoring devices, clamps and similar accessories required for the complete installation of work, matching or compatible with material being installed, non-corrosive, size and gauge recommended by installer to suit application and performance.
- F. Sealant:
 - 1. Type A:
 - a. Type: One-part, non-sag, moisture-curing polyurethane sealant.
 - b. Approved Products / Manufacturers: "Chem-Calk 900" manufactured by Bostik Construction Products Division, "Vulkem 921" manufactured by Mameco International, Inc., "Dynatrol I" manufactured by Pecora Corporation, "MasterSeal NP 1" manufactured by BASF, or approved equal.
 - 2. Type B:
 - a. Type: One-part, neutral-curing, medium-modulus silicone sealant for sealing metal to metal surfaces, i.e. metal edge, cover plates, etc.
 - b. Approved Products / Manufacturers: "Chem-Calk 1200" manufactured by Bostik Construction Products Division, "795 Silicone Building Sealant" manufactured by Dow Corning Corporation, "895 Silicone" manufactured by Pecora Corporation, "Omniseal" manufactured by Sonneborn Building Products, "Spectrem 2" manufactured by Tremco Incorporated, or approved equal.
- G. Grout - Pitch Pans:
 - 1. Type: Quick-setting, non-shrink, non-metallic, high strength formula complying with ASTM C1107.
 - 2. Approved Products / Manufacturers: "Sure Grip High Performance Grout" manufactured by Dayton Superior Corporation, "Premier Quick-Trim" manufactured by L & M Construction Chemicals, Inc., "MasterFlow" manufactured by BASF, or approved equal.
- H. Pitch Pan Filler:
 - 1. Type: Pourable polyurethane sealer, approved by roofing system manufacturer.
 - 2. Approved Products / Manufacturers: "Quick Pitch Sealer" manufactured by U.S. Intec, "SPM Pourable Sealer" manufactured by Johns Manville, or approved equal.
- I. Termination Bar:
 - 1. Material: Stainless steel or extruded aluminum bar with lipped profile.
 - 2. Size: 1/8 inch thick by one (1) inch wide with factory punched 1/4 inch x 3/8 inch oval holes spaced six (6) inches on center.

- 3. Approved Product / Manufacturer: "TB 125" manufactured by TruFast Corp., or approved equal.
- J. Pipe Hangers and Supports: Refer to Section 07 72 00, Roof Accessories.
- K. Splash Blocks: Concrete type, of size and profiles indicated; minimum 3,000 psi compressive strength at 28 days, with minimum five (5) percent air entrainment. Use at locations where roof drainage discharges on ground.
- L. Splash Pans: 22 gauge stainless steel, of size and profiles indicated. Use at locations where roof drainage discharges over adjoining, lower roof level(s).

2.5 FABRICATION

- A. Except as otherwise indicated, fabricate work in accordance with SMACNA Architectural Sheet Metal Manual and other recognized industry practices and reviewed shop drawings. Form all flashings, receivers and counterflashings in accordance with standards set forth in the NRCA roofing manual and SMACNA.
- B. Comply with manufacturer's installation instructions and recommendations.
- C. Shop fabricate Thru-wall, counterflashings, expansion joint metal and wind clips to greatest extent possible.
- D. Fabricate items to size and dimensions as indicated on the drawings. Limit single-piece lengths to twelve (12) feet for prefabricated pieces and ten (10) feet for shop fabricated pieces.
- E. Face of any fabricated vertical metal fascia or coping shall not exceed 8" without stiffener band or birds beak. If stiffener band or birds beak cannot be fabricate, contractor to use multiple pieces of metal to achieve overall distance without going over the 8" maximum per piece.
- F. Fabricate for waterproof and weather-resistant performance; with expansion provisions for running work sufficient to permanently prevent leakage, damage or deterioration of the work.
- G. Integrate flashing in a manner consistent with membrane waterproofing detailing. Form work to fit substrates.
- H. Make angle bends and folds for interlocking metal with full regard for expansion and contraction to avoid buckling or fullness in metal after installation.
- I. Fabricated items will have straight lines, sharp angles, smooth curves, and true levels. Avoid tool marks, buckling, and oil canning.
- J. Fold back edges on concealed side of exposed edge to form hem.
- K. Unless noted otherwise, lap joints minimum three (3) inch. Lap joints to have sealant installed as per details, to maintain watertight condition, inside and outside corners and elevation changes to be riveted and soldered.
- L. Seams:
 - 1. Wherever possible, fabricate non-moving seams in sheet metal with flat-lock seams and end joints.

2. Pre-finished Galvanized Steel: Seal pre-finished metal seams with rivets and silicone sealant.
 3. Metal Other than Aluminum: Tin edges to be seamed, form seams, and solder.
- M. On Kynar 500 or Hylar 5000 pre-finished metal, surface sand metal flanges prior to applying any primers. Prime all metal in contact with bituminous material.
- N. Backpaint all concealed metal surfaces with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals.
- O. Expansion Provisions: Where lapped or bayonet type expansion provisions in work cannot be used or would not be sufficiently waterproof or weatherproof, form expansion joints of intermeshing hooked flanges, not less than one (1) inch deep filled with mastic sealant concealed within joints.

2.6 FABRICATED ITEMS

- A. Metal Flashings:
1. Through Wall Receiver Tray: Minimum 24 gauge stainless steel formed in maximum ten (10) foot lengths, through wall receivers shall not extend past the face of the exterior veneer more than $\frac{3}{4}$ ".
 2. Counterflashings: Minimum [24 gauge stainless steel] formed in maximum ten (10) foot lengths.
- B. Wind Clips: Minimum 24 gauge stainless steel (or match material of counterflashing), one (1) inch wide by length to engage counterflashing a minimum of $\frac{1}{2}$ inch. To be installed at all wall flashings and at curb flashing lengths longer than 5 feet.
- C. Roof Penetrations:
1. Umbrella Counterflashing: Two-piece construction of minimum 22 gauge stainless steel, fabricated in accordance with drawings or project requirements.
 2. Flashing Pans:
 - a. 24 gauge stainless steel.
 - b. Fabricate to provide installed minimum clear inside perimeter dimension of two (2) inches on each side of penetrating element.
 - c. Fabricate pans to at least six (6) inches above the finished roof membrane and with $\frac{1}{4}$ inch hem at top edge and with four (4) inch flanges. Round all corners of flange.
 - d. Fabricate metal bonnets for all pans, NO EXCEPTIONS. Fabricate bonnets with metal compatible with metal to which bonnet is to be attached. On beams and other steel, weld in place bonnets fabricated from $\frac{1}{4}$ inch steel plate. Draw band bonnets fabricated from 22 gauge stainless steel may be used on circular projections.
- D. Metal Edge / Fascia:
1. Perma-Tite System 200 Fascia for thermoplastic roof systems: Decorative metal fascia with continuous formed rail.
 - 1) Construction:
 - a) Fascia metal gauge
 - 1) 24 gauge galvanized steel.
 - b) Finish:
 - 1) Kynar-500 color as selected by the Architect from roof edge manufacturer's full range of colors.
 - c) Formed Rail: Shall be continuous 20 gauge galvanized steel at

- 12'-0" standard lengths with pre-punched slotted holes and 6" stainless steel springs at 4'-0" on center.
- 2) Thermoplastic Version
 - a) Model:
 - 1) FA-80 (8.25" Face)
 - b) Performance:
 - 1) 20 year, 180 mph Wind Warranty.
 - 2) Tested per ANSI / SPRI ES-1 / FM 4435 Standard to a design pressure of 200 psf to comply with the International Building Code.
 - 3) FM tested to a minimum FM 1-180 rating
- E. Metal Coping
- 1. Perma-Tite Coping
 - 1) Construction:
 - a) Metal:
 - 1) 24 gauge galvanized steel.
 - b) Finish:
 - 1) Kynar-500 color as selected by the Architect from roof edge manufacturer's full range of colors.
 - 2) Coping Cap: Length of 12'-0", widths to 24" manufactured to job requirements. True radii may be built to template.
 - 3) Coping Vertical Face and Back Leg: 2 1/4" to 12 1/2" manufactured to job requirements.
 - 4) Concealed Splice Plates: 8" wide. Finish to match finish of coping cap with factory applied dual non-curing sealant strips.
 - 5) Anchor / Support Cleat: 20 gauge pre-punched galvanized cleat with stainless steel spring mechanically locked to cleat normally 12" wide at 4'-0" on center. Mechanically fastened as indicated and detailed.
 - 6) Fasteners: 1 1/2" stainless steel with driver.
 - 7) Performance:
 - a) 20 Year, 160 mph Wind Warranty
 - b) Tested per ANSI / SPRI ES-1 / FM4435 Standard to comply with the International Building Code.
 - c) Factory Mutual 1-90 approved for wind up lift protection.
 - d) Miami-Dade Approved (No. 13-0419.03 12/11/18) to comply with the "High Velocity Hurricane Zone of the Florida Building Code".
- F. Continuous Cleats (where applicable): Continuous strips, same material and profile, minimum one gauge heavier of item which cleats attach.
- G. Vent Hoods, Sleeves, Penetration Flashings, and Accessories: Minimum 24 gauge stainless steel, or as shown or directed otherwise.
- H. Angle Termination Bar: Aluminum pressure bar 1/8 inch x one (1) inch.
- I. Vent Pipe Flashing: Four (4) pound lead. Provide proper size to fold down inside of pipe a minimum of one (1) inch.
- J. Gutters / Downspouts / Collector Heads: Seal-Tite Industrial Gutter System by manufacturer.
- 1. Minimum [24 gauge prefinished galvanized steel], formed in maximum twelve (12) foot lengths.
 - 2. Match dimension of existing. Verify gutter and downspout meets rainfall data as outlined in SMACNA.

3. Seal-Tite Industrial Gutter, including 2" Wide Gutter Straps 24" o.c., Wind Straps 6'-0" o.c., 1/8" Stainless Steel Pop Rivets, and #10 x 2" Stainless Steel Fasteners to be manufactured and supplied to suit profile and dimension of gutter and downspout by manufacturer.
4. 24 gauge galvanized steel with membrane manufacturer's coating (specify)
5. For Single Ply roofing systems: Drip Edge with Factory Applied Flashing PVC).
6. End Caps, Downspout Outlets, Gutter and Downspout Straps, Support Brackets and joint fasteners to be manufactured to suit profile and dimension of gutter and downspout.
7. Install all anchoring devices as outlined in manufacturer literature.
8. Expansion Joints: Style 1 per manufacturer, locate every 50 linear feet.
9. Gutter Straps and Supports: Minimum 3 per 12'-0" length, .100 inch thick downspout straps: Strap type, like metal, match color.
10. Downspouts: Minimum [24 gauge prefinished galvanized steel] (match color).
11. Downspout straps: Strap type, like metal, match color.
12. Gutter Screen: .050" Aluminum with 1/4" dia. perforations
13. Collect Heads: Minimum [24 gauge prefinished galvanized steel] (match color). As outlined in SMACNA; Refer to Figure 1-25F and Figure 1-28 with alternate Section A-A.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify substrates are smooth and clean to extent required to perform sheet metal work.
- B. Verify roof openings, curbs, pipes, sleeves, ducts or vents through roof are solidly set in place.
- C. Verify that reglets, nailers, cants, and blocking to receive sheet metal are in place and free of concrete and soil.
- D. Do not start work until conditions are satisfactory.

3.2 PREPARATION

- A. Field measure site conditions prior to fabrication work.
- B. Install starter and edge strips and cleats before starting installation.

3.3 INSTALLATION

- A. 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 1/4 inch hem on concealed side from view. Finished work shall be free from water retention and leakage under all weather conditions. Prefabricated corners or transitions are required at changes in direction, elevation, or plane and at intersections. Locate field joints not less than 12 inches, nor more than three (3) feet from actual corner. Laps shall be one (1) inch, riveted and soldered at following locations:
 1. Prefabricated corners;
 2. transitions;
 3. changes in direction, elevation, and plane; and
 4. at intersections.

- B. Anchor units of work securely in place to prevent damage or distortion from wind or buckling. Provide for thermal expansion of metal units; conceal fasteners wherever possible; and set units true to line and level as indicated. Install work with laps, joints, and seams which are permanently watertight and weatherproof.
- C. Install fabricated sheet metal items in accordance with manufacturer's installation instructions and recommendations and with SMACNA Architectural Sheet Metal Manual.
 - 1. Ensure approved fasteners are used throughout the project.
 - 2. Ensure fasteners are installed in manufacturer pre-punched holes on rails, extrusions, clips and cleats.
 - 3. Ensure sufficient amount of waterblock is applied where appropriate to prevent leaking under rails/extrusions. **Contractor is responsible for cleaning stained brick and remedying for total length of workmanship warranty if waterblock is not installed appropriately.**
- D. Separations: Provide for separation of metal from dissimilar metal or corrosive substrates by coating concealed surfaces with zinc chromate, bituminous coating, or other permanent separation at locations of contact as recommended by manufacturer or fabricator. Do not use materials which are incompatible with roofing system.
- E. Cleat: At exposed edges of perimeter edge, fascias, cap flashings, and where required, attach cleat with appropriate fasteners supplied by roof edge manufacturer. Install cleat so fascia extends a minimum of 1 inch below top of exterior wall finish.
- F. Counterflashing:
 - 1. Do not use surface mount counterflashing except as noted in drawings.
 - 2. Set in through wall with receiver and spring lock counterflashing, as detailed in drawings and to NRCA roofing manual, SMACNA standards.
 - 3. Coordinate installation of through-wall flashing with the masonry contractor.
 - 4. Seal through-wall in conjunction with masonry wall waterproofing.
 - 5. Install wind clips 30 inches o.c. at all counterflashing over five (5) feet in length.
- G. Pitch Pans, Metal Flanges (As Required):
 - 1. Apply mastic under pitch pan or metal flashing flange at least 1/2 pound per linear foot.
 - 2. Prime all metal flanges with asphalt primer prior to flashing installation.
 - 3. Clean all projections enclosed in pitch pans in any manner suitable and coated with a rust inhibitive coating as approved by the Architect. Coating shall be allowed to dry prior to pitch pan fill.
 - 4. Fill base of pitch pans with grout or cementitious binder and allow to cure.
 - 5. Top Finish Fill: Self-leveling, one-part urethane; at least two (2) inches to top of pitch pan sides.
 - 6. Strip in pitch pan flanges with two strips of specified stripping plies set in hot bitumen extending three (3) inches from the outer edge of the flange to at least three (3) inches inward toward base of pitch pan. Provide finish stripping ply of SBS modified bitumen membrane in hot bitumen extending six (6) inches from the outer edge of the flange and butt to base of pitch pan.
- H. Sanitary Vent Stacks Modified Bitumen
 - 1. Prime top and bottom flanges of lead flashing sleeve. Set flange in uniform troweling of plastic roof cement. Prime top side of flange to receive strip-in membrane.

2. Fold lead sleeve down inside of pipe a minimum of one (1) inch. Apply a continuous bead of sealant on inside of pipe prior to folding lead sleeve.
- I. Sanitary Vent Stacks: Thermoplastic Roof System
1. Prepare substrate and fit pre-molded pipe boot.
 2. Heat weld pipe boot flange to prepared thermoplastic field membrane.
 3. Apply sealant as recommended by membrane manufacturer to inside of the top edge of the pipe boot. Install stainless steel pipe clamp ensuring no wrinkles or folds in the pipe boot membrane. Apply second bead of sealant at the top of the pipe boot.
 4. Install sheet metal umbrella flashing, pipe clamp and sealant above top of pipe boot.
- J. Gutters / Downspouts:
1. Install gutters prior to edge metal and otherwise as detailed.
 2. Install downspouts plumb and level, attached to columns or wall with straps located at top and bottom of downspout and maximum ten (3) feet on center (note: 3 per 12' lengths supplied by manufacturer).
 3. Install splash pad or block under discharge port of downspouts (if non exist). Install splash pan over a protection (walkway) pad for downspouts located at roof level.

3.4 CLEANING AND PROTECTION

- A. Remove flux and residual acid immediately by neutralizing with baking soda and washing with clean water. Leave work clean of stains.
- B. Remove scraps and debris and leave work area clean.
- C. Clean exposed metal surfaces, removing substances which might cause corrosion of metal or deterioration of finishes. Paint areas where finish is damaged on pre-finished metal by painting with a compatible paint in color to match undamaged finish.
- D. Prime soldered area of phosphatized metal after cleaning to prevent rusting.
- E. Paint metal flashings that have been soiled with bitumen with aluminized paint.
- F. Clean other work damaged or soiled by Work of this Section.
- G. Protect finished work from damage.

END OF SECTION 07 62 00

SECTION 07 65 00 - FLEXIBLE FLASHING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Provide flexible flashing where shown on drawings or required.

1.3 RELATED SECTIONS

- A. Section 07 52 20 – Modified Bitumen Cool Roof Membrane
- B. Section 07 54 20 – Adhered PVC Decor

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Certification: Manufacturer's affidavit that materials used in Project contain no asbestos.
- C. Compatibility: Submit letter from primary Fluid Applied Air Barrier System Manufacturer stating that materials proposed for use are permanently chemically compatible and adhesively compatible with adjacent materials proposed for use. Submit letter from Manufacturer stating that cleaning materials used during installation are chemically compatible with adjacent materials proposed for use.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Manufacturers listed whose products meet or exceed the specifications are approved for use on the Project. Flexible flashing materials used shall be compatible with and not void any warranties of the air barrier system used. Other manufacturers must have a minimum of five (5) years' experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.

2.2 MATERIALS

- A. Flashing:
 - 1. Copper Laminated Flashing (Contractor's Option – in lieu of asphalt-free copper fabric flashing):
 - a. Flashing: A full sheet of copper weighing five (5) ounces per square foot coated or bonded on both sides with one (1) of the following:
 - 1) Modified asphalt compound coated.
 - 2) Asphalt saturated, waterproof glass fiber laminated fabric.
 - b. Approved Manufacturers:
 - 1) Advanced Building Products, Inc.

- 2) Hohmann & Barnard, Inc.
 - 3) Sandell Manufacturing Company, Inc.
 - 4) York Manufacturing, Inc.
 - c. Mastic: Manufacturer recommended asphalt troweled mastic for sealing copper laminated flashings
2. Asphalt-free Copper Fabric Flashing (Contractor's Option – in lieu of copper laminated flashing):
 - a. Glass fabric scrim bonded to a full sheet of copper for general through wall flashing as an alternative to asphalt coated copper specified above and where sealant compatibility is required. Provide manufacturers approved sealant or seam tape.
 - b. Approved Product / Manufacturer: Multi-flash 500 as manufactured by York Manufacturing, Inc.; or Copper-Fabric NA or Copper-Fabric SA as manufactured by Hohmann & Barnard, Inc. (No substitutions).
3. Asphalt-free Stainless Steel Flexible Flashing (Contractor's Option – in lieu of copper laminated or asphalt-free copper fabric flashing):
 - a. Flexible minimum 2 mil thickness, Type 304 stainless steel sheet with factory applied adhesive with a release liner on one side for general through wall flashing as an alternative to asphalt coated copper specified above and where sealant compatibility is required. Provide manufacturers approved sealant or seam tape.
 - b. Approved Product / Manufacturer: York 304 as manufactured by York Manufacturing, Inc.; or Mighty-Flash-SA as manufactured by Hohmann & Barnard, Inc. (No substitutions).
4. Membrane Flashing:
 - a. Self-Adhered Flexible Flashing: 40-mil, rubberized asphalt adhesive reinforced flashing with a high density cross laminated polyethylene film. Provide compatible substrate primer as instructed by Manufacturer.
 - b. Approved Products / Manufacturers:
 - 1) "CCW-705 TWF" manufactured by Carlisle Coatings and Waterproofing
 - 2) "Perm-A-Barrier" manufactured by W. R. Grace & Co.
 - 3) "Blueskin TWF" manufactured by Henry Co.
 - 4) "Air-Shield Through wall flashing" manufactured by W.R. Meadows, Inc.
 - 5) "TW-Thru Wall Flashing" manufactured by Tamko Waterproofing.
 - 6) AquaFlash 500" manufactured by Fiberweb.
5. Substrate Primer: Provide as instructed by Membrane Manufacturer.
6. Termination Bar: 14 ga. minimum thick by 1" minimum wide stainless steel, with pre-punched holes and ¼" minimum shouldered top flange. Provide with self-tapping screws.
7. Weathering Flange at Door / Window Openings: Provide a 20 gauge (0.040") stainless steel or .040 aluminum 2"x3" weathering flange at head, jamb and under sill pan of storefront window and hollow metal door systems. Screw attach into wood blockings or substrate walls and strip into air barrier system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Flashing:
1. Follow manufacturer's instructions for mechanically fastened installation with a termination bar.
 2. Application Guidelines - Install flashing at the following locations:
 - a. Membrane Flashing: material transitions inside exterior cavity walls, roof edge / exterior wall transitions, masonry joints (control/expansion) inside exterior cavity walls, exterior door and window frame perimeters, roof deck / exterior wall transitions, exterior wall penetrations (i.e. pipe, conduit, ducts, etc.). Provide membrane at all joints, holes, gaps, or openings to ensure a continuously sealed building envelope. Utilize primer on substrates as instructed by manufacturer.
 - b. Copper Flashing: At all horizontal wall flashing, including (but not limited to) exterior wall sill / weep conditions, exterior door and window head / weep conditions, intermediate and / or shelf angles, masonry wall cap flashing and masonry wall base flashing.
 3. Apply substrate primer as instructed by membrane manufacturer to suit condition.
 4. Provide drip edge flashing at weep conditions with membrane flashing. Cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind with outside edge of brick over top of drip edge flashing to alleviate exposure to UV degradation and deterioration of asphalt membrane.
 5. On Horizontal Surfaces: The flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. The flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches. Flashing will then be secured in back wall with termination bar.
 6. On Vertical Surfaces: Surfaces receiving the flashing shall be sufficiently spotted with asphalt mastic to hold in place until masonry is set. Secure in back wall with termination bar.
 7. Foundation Sill Dampproofing: The flashing for foundation sills shall be laid in a slurry of fresh mortar or in a full bed of mastic and topped with a fresh full bed of mortar. The flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be sloped across the cavity and turned up the wall a minimum of ten (10) inches and secured to back wall with termination bar. Where sill and column meet, flashing shall be brought up a minimum of ten (10) inches up the column.
 8. Thru-Wall Flashing: Shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Carry flashing through the wall, turned up where possible to facilitate drainage through the weepholes, then carried upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secure in back wall with termination bar.
 9. Lintel: Premolded or field molded end dams must be provided at each end of all lintels.

10. Cavity Wall: Flashing shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise, and secured in the back wall with termination bar. Vertical membrane joints shall be secured with termination bar as instructed by membrane manufacturer.
 11. Heads, Jambs and Sills: Flashing for heads and sills shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Flashing shall be carried through the wall and upward across the cavity a minimum of six (6) inches, unless noted otherwise. Head flashing shall be carried six (6) inches beyond both end of the steel lintel. Both head and sill flashing shall be turned up at the sides to form a pan. All corners shall be folded, NOT CUT. Jambs are to be turned into the buildings to complete seal perimeter of window or door. Install weepholes.
 12. Windows: wrap all heads, sills and jambs into opening with flexible flashings.
 13. Wood blockings: Flexible flashings are to cover wood blockings in their entirety.
 14. Spandrels: Spandrel flashing shall start from the outside toe of the shelf angle, go up the face of the beam and then through the wall, turned up on the inside not less than two (2) inches. Install weepholes.
 15. Parapet or Coping: Flashing for parapets or coping sills shall be laid in a slurry of fresh mortar and topped with a fresh full bed of mortar. Flashing shall be cut $\frac{1}{4}$ " to $\frac{1}{2}$ " behind the exterior face of the wall after being left exposed for inspection purposes only. Weepholes shall be installed immediately on top of the flashing.
 16. Lengths: Install flashings without longitudinal joints within walls, if possible. If required materials are not available in a single width, join by lapping material minimum two (2) inches and seal joint throughout its length with adhesive.
 17. End Joints: Avoid end joints in flashing. When end joints are necessary, lap flashing minimum six (6) inches and seal joint continuously with adhesive.
 18. Penetrations: Where anchors, pipes, and inserts penetrate flashing, make opening in flashing snug and seal with adhesive.
 19. Reglet Termination: Insert wedge into place and seal carefully with adhesive.
 20. Termination Bar: Install flashing with termination bars in accordance with manufacturer's instructions. Provide 3 coursing at all termination bars, typical.
 21. Top Coat: After flashing material is in place (except in masonry joints where bond and mortar is required) trowel full $\frac{1}{8}$ inch protective coating or mastic on all flashing faces.
 22. Lintels: Provide pre-molded end dams at all lintel ends.
- B. Bed Joints: Coordinate work with Division 4, Masonry. Install thru-wall flashings between two (2) thin layers of masonry mortar without increasing thickness of mortar joint. Keep outer edge of flashing material back $\frac{3}{4}$ inch from face of masonry.

3.2 APPLICATION

- A. Protect membrane from overexposure to direct sunlight.
- B. Follow manufacturer's recommendations for installation.
- C. Adjacent Work: Protect work by masking, covering, or other precautionary methods. Remove protection when no longer necessary.

END OF SECTION 07 65 00

SECTION 07 22 00 - ROOF ACCESSORIES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 INSTALLATION RESPONSIBILITY

- A. In addition to the items normally a part of this Section, coordinate the installation of roof accessory curbs and pipe flashings and equipment supports that may be specified elsewhere.
- B. Coordinate the Work specified herein with the following Work:
 - 1. Roofing
 - 2. Roofing sheet metal
 - 3. Mechanical equipment
 - 4. Plumbing
 - 5. Electrical

1.3 REFERENCES

- A. Federal Specifications (FS)
 - 1. TT-S-00227E
- B. National Roofing Contractors Association (NRCA)
- C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
 - 1. Architectural Sheet Metal Manual

1.4 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature, and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- B. Shop Drawings: Indicate size, material, and finish. Show locations and installation procedures. Include details of joints, attachments, and clearances.
- C. Contractor to provide proof of membrane material compatibility for roof bracing and supports.(Refer to section 2.6)

1.5 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.

1.6 WARRANTY

- A. Warranty the Work specified herein for one (1) year against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Noticeable deterioration of finish

2. Water infiltration into the building or within the construction.
- C. Rooftop supports – 5 year limited warranty.
- D. Roof bracing – 20 year limited warranty included in roofing warranty.
 1. Water infiltration into the building or within the construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Specifications are based on products of named manufacturers. Other manufacturers must have a minimum of five (5) years' experience manufacturing products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.

2.2 PREFABRICATED ROOF CURBS

- A. Frames:
 1. Material: ASTM A 653 G90 hot-dipped galvanized steel.
 - a. Minimum 18 gauge, and as engineered by manufacturer.
 - b. Minimum 18 gauge for curbs supporting HVAC units
 - c. Minimum 20 gauge for expansion joint curbs.
 2. Corners: Mitered and welded (welds are micro sealed and prime painted after fabrication). Bolted connections not accepted.
 3. Base Plates: Integral to frame and welded.
 4. Internally reinforced with galvanized 1 inch by 1 inch by 12 gauge angles for curbs exceeding 3 foot length. Reinforce internal bulkhead at equipment curbs to support lateral loads.
 5. Wood Nailers: Factory installed, pressure treated. Size and width as suitable for support of items installed on curbs.
- B. Insulation: Factory installed 1-1/2 inch thick three-pound density fiberglass insulation.
- C. Curb Height: Minimum 8 inch above finished roof.
 1. Construct curbs to match roof slope with plumb and level top surface for mounting mechanical equipment.
- D. Gasketing: 1/4 inch thick, one (1) inch wide at roof top units.
- E. Counterflashing: 24 gauge stainless steel
- F. Counterflashing Cap: Stainless steel.
- G. Cants:
 1. Non-canted curb style installs either under or on top of metal decks with insulation.
 2. Cants shall be provided under Section 07 52 19 – Roofing
- H. All insulated roof curbs shall be structural and shall include calculations signed and sealed by a registered Structural Engineer. Refer to installation drawings for any additional structural requirements. If curbs do not span a minimum of two bar joists, only two angles will be required. Coordination mechanical equipment weight loading on the roof with Structural Engineer.

- I. Approved Manufacturers:
 - 1. Custom Curb, Inc.
 - 2. Roof Products, Inc.

2.3 PIPE SUPPORTS (Contractor built supports are not allowed)

- A. Gas Pipe Supports:
 - 1. Provide pipe roller type support with bases of high density / high impact injection molded polypropylene with UV inhibitors (10" x 16" x 3"; 5.5 lbs. each) and stainless steel rods, washers and nuts; Basis of design, PHP Systems / Design Model PP10-R with roller for gas pipe 3" O.D. and smaller.
 - 2. Provide hanger type support with bases of high density / high impact injection molded polypropylene with UV inhibitors (12" x 12" x 3"; 3 lbs. each or 18" x 18" x 3"; 7 lbs. each or 18" round; 10.5 lbs. each) and stainless steel rods, washers and nuts; Basis of design, PHP Systems / Design Model PS-1-2 with hanger for gas pipe larger than 3" O.D.
 - 3. Acceptable Manufacturers: Miro Industries Inc.; MAPA Products; Advanced Support Products, nVent Caddy or Architect approved equal.
- B. Electrical Conduit / Condensate Pipe Supports:
 - 1. Provide channel / strut type support with bases of high density / high impact injection molded polypropylene with UV inhibitors (10" x 16" x 3"; 5.5 lbs. each) and stainless steel channel, rods, washers and nuts; Basis of design, PHP Systems / Design Model PP10-C with channel for condensate pipe or conduit 3" O.D. and smaller.
 - 2. Provide hanger type support with bases of high density / high impact injection molded polypropylene with UV inhibitors (12" x 12" x 3"; 3 lbs. each or 18" x 18" x 3"; 7 lbs. each or 18" round; 10.5 lbs. each) and stainless steel rods, washers and nuts; Basis of design, PHP Systems / Design Model PS-1-2 with hanger for condensate pipe or conduit larger than 3" O.D. Contractor to provide channel clamp at each support. Provide dissimilar metal protection as required.
 - 3. Acceptable Manufacturers: Miro Industries Inc.; MAPA Products; Advanced Support Products, nVent Caddy or Architect approved equal.
- C. Chilled Water Pipe Supports:
 - 1. Provide hanger type support with bases of high density / high impact injection molded polypropylene with UV inhibitors (18" x 18" x 3"; 7 lbs. each or 18" round; 10.5 lbs. each) and stainless steel rods, washers and nuts; Basis of design, PHP Systems / Design Model PS-1-2 or Model PS-2-2 or Model PSE Custom as required with hanger(s) for chilled water pipe of any diameter.
 - 2. Acceptable Manufacturers: Miro Industries Inc.; MAPA Products; Advanced Support Products, nVent Caddy or Architect approved equal.
- D. Crossover / Steps Pipe Supports:
 - 1. Provide channel / strut type support with bases of high density / high impact injection molded polypropylene with UV inhibitors and stainless steel channel, rods, washers and nuts; Basis of design, PHP Crossover.
 - 2. Acceptable Manufacturers: Miro Industries Inc.; MAPA Products; Advanced Support Products, nVent Caddy or Architect approved equal.
- E. Installation:
 - 1. Provide pipe supports at no greater than 8'-0" o.c. or as otherwise indicated in Manufacturer's Shop Drawings.

2. Provide pipe supports spaced so deflection of piping does not exceed 1/240 of span. If deflection exceeds 1/240 of span, decrease support spacing to 6'-0" o.c.
3. Provide complete and adequate support of all piping, ducts and conduit.
4. Provide protective isolation pads adhered to the roof system below each pipe support using Roof System Manufacturer's approved adhesive.
5. Provide each pipe support adhered to the protective isolation pads using Roof System Manufacturer's approved adhesive.

2.4 ROOF TO ROOF EXPANSION JOINT

- A. Stainless Steel expansion joint covers on new wood curbs, as detailed on drawings and outlined the NRCA and SMACNA manual.

2.5 RETROFIT ROOF DRAINS

- A. Retrofit Roof Drains: "Hercules RetroDrain" as manufactured by OMG, Inc. or Architect approved equal.
 1. Size: To match existing roof drain sizes. [3 inches] [4 inches] [5 inches] [6 inches] [Indicated on the Drawings].
 2. Compliance:
 - a. ANSI / SPRI RD-1.
 - b. ULC / ORD-C790.4.
 3. Drain Body:
 - a. Material: 1-piece, 11-gauge (0.125-inch) spun aluminum.
 - b. Flange: 17-1/2-inch diameter.
 4. Drain Stem Length: 12 inches
 5. Flange Includes: Six 2-1/2-inch-long aluminum studs.
 6. Sump Area: Depressed.
- B. Strainer Dome:
 1. Material: Cast aluminum.
 2. Height: 7.25 inches.
 3. Outside Base Diameter: 9.77 inches.
- C. Clamping Ring:
 1. Material: Cast aluminum.
 2. Gravel Stop Height: 1.2 inches.
 3. Drainage Slots: 18 V-shaped.
 4. Bosses: 6, to accept studs on flange.
- D. Backflow Seal:
 1. Compression Seal: Watertight, "U-Flow" mechanical seal.
 2. Material: Polyamide and EPDM rubber.
 3. Required for Activation: "U-Flow" screwdriver.
- E. Hardware:
 1. Locknuts: 6, stainless steel, for studs.
 2. Screws: 3, stainless steel, to attach strainer to clamping ring.
- F. Overflows:
 1. At overflow locations; provide overflow collar extension
 2. Constructed of spun aluminum

2.6 MISCELLANEOUS ROOF BRACING AND SUPPORT SYSTEMS

- A. Provide U-Anchors made of 304 stainless steel with 3/8" bolt and galvalume plate. Utilize same membrane as roofing manufacturer to be inclusive in 20 YEAR NDL warranty
- B. As manufactured by Anchor Products Model U-anchor 2000 Series as required for condition or nVent Caddy Pyramid Anchor system

2.7 ROOF PENETRATION HOUSING

- A. Provide rain-proof one-piece configuration consisting of a removable vandal resistant lid, middle housing, insulation extension (ICE) and wide flanged curb that is light weight and water tight. To be used with our exclusive two-piece aluminum and / or stainless steel flanged Exit Seal with SilX14TM gasket. Provide 20 Year insured warranty.
- B. As manufactured by Roof Penetration Housing Model AWI Series Vault as required for condition or Architect approved equal.

2.8 ROOF DRAIN / DOWNSPOUT WALL NOZZLE

- A. Downspout Wall Nozzle at Concealed Roof Drain Leader / Discharge: Josam 25010 Series cast bronze Downspout Nozzle with loose flange and inlet threaded connection or Architect approved equal. Diameter appropriate to downspout size.

2.9 FALL ARREST ROOF ANCHORS

- A. Fixed Roof Anchor: Provide fixed eye or stanchion type for continuous travel. Provide for structural anchorage as required for roof framing condition. Provide integral energy absorbing components. Provide with Type 304 stainless steel forged eye, anchor posts, intermediate / corner / end stanchions and connection devices. Provide for dissimilar metal protection.
 - 1. Acceptable Manufacturers: Rooftop Anchor, Inc., "Horizontal Lifeline Systems"; FixFastUSA, "Travel 8 Static Line System – Top Mount SL200"; Thaler Metal
- B. Horizontal Wire Rope: Provide minimum breaking strength of a terminated wire rope to be at least twice the MAL, but not less than 6,500 lbf. The minimum rope diameter shall be 5/16". Wire rope lines shall comply with CSA G4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof accessories in accordance with manufacturer's printed instructions and approved shop drawings. Installation of Portable Pipe Hangers shall not exceed six (6) feet on center.
- B. Coordinate with roofing operation for watertight integrity.
- C. Finished installation shall be water and air tight. Install sealant conforming to FS TT-S-00227E, Type II, Class A.

END OF SECTION 07 72 00

SECTION 07 22 33 - ROOF SCUTTLE (HATCHES)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 RELATED WORK

- A. Section 06 10 00 - Rough Carpentry
- B. Section 07 52 20 – Modified Bitumen Cool Roof Membrane
- C. Section 07 54 23 – Adhered PVC Decor

1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a watertight installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 SUBMITTALS

- A. Product Data: Submit schedules, charts, literature and illustrations to indicate the performance, fabrication procedures, product variations, and accessories.
- B. Shop Drawings: Include materials, opening sizes, fabrication details, hardware, attachments, related and adjacent work, and finishes.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Miami-Dade County, FL Approved NOA
 - a. TAS 201 Impact test
 - b. TAS 202 Uniform Static Air Pressure
 - c. TAS 203 Cyclic Wind Pressure Loading
 - 2. OSHA 29 CFR 1910.23 Guarding floor and wall openings and holes
 - 3. OSHA 29 CFR 1926.502 Fall protection systems criteria
 - 4. International Building Code (IBC) Section 1013.6 Roof Access
 - 5. International Building Code (IBC) Section 1009.11 Means of Egress, Stairways, Stairway to Roof
 - 6. International Building Code for venting requirements
 - 7. IBC Section 410 for Stages and Platforms
 - 8. IBC Section 910 for Factory and Storage occupancies
 - 9. IBC Section 1207 Sound Transmission
 - 10. Underwriters Laboratories Inc, UL 793 Listed for Heat and Smoke Vents
 - 11. FM Global, Factory Mutual, FM 4430 Heat and Smoke Vents for Roofs
 - 12. Reference NFPA 204 for general maintenance of Heat and Smoke vents
 - 13. ASTM E 90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to Project site ready use.
- B. Exercise proper care in handling of Work so as not to disrupt finished surfaces.
- C. Store materials under cover in a dry and clean location off the ground.

1.7 WARRANTY

- A. Warrant the work specified herein for five (5) years, against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to, the following:
 - 1. Faulty, improper or inadequate attachment or installation.
 - 2. Difficult or noisy operation.
 - 3. Noticeable deterioration of finish.
 - 4. Leakage of water into the building or within the construction.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Basis of Design Product: Subject to compliance with requirements: The Bilco Company.
- B. Manufacturers listed below whose products are equivalent to those specified are approved for use on the Project. Other manufacturers must have a minimum of five (5) years experience manufacturing equivalent products to those specified and comply with Division 1 requirements regarding substitutions to be considered.
 - 1. Acudor Products Inc.
 - 2. Babcock-Davis Hatchways, Inc.
 - 3. Dur-Red Products
 - 4. J. L. Industries, Inc.
 - 5. Karp Associates, Inc.
 - 6. Nystrom Building Products

2.2 ROOF SCUTTLES (HATCHES)

- A. Size: 2'-6" x 3'-0 unless shown otherwise.
- B. Finish: Mill Finish Aluminum White Powder Coat Aluminum.
- C. Thermally Broken Cover: Shall be 11 gauge aluminum with 3" concealed polyisocyanurate insulation, 5" beaded, overlapping flange, welded at corners, and internally reinforced for 40 psf live load., covered and protected by an aluminum liner. No water standing on top of the cover will be permitted.
- D. Thermally Broken Curb: Shall be 12 inches in height above finished roof surface and constructed of 11 gauge aluminum. It shall be formed with a 5-1/2 inch flange with holes provided for securing to the roof deck. Curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, full welded at the corners for weathertightness. Capflashing shall be equipped with the Bilclip™ flashing system,

including stamped tabs and Pak-Rope. Insulation on the exterior of the curb shall be rigid fiber board three (3) inches in thickness.

- E. Thermally Broken Scuttle (Hatch): Shall be completely assembled with heavy pintle hinges, positive snap latch with turn handles, padlock hasps inside and outside, and a mechanically retained thermoplastic rubber gasket. Compression spring operators enclosed in telescopic tubes shall be provided for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature. Cover shall be equipped with an automatic hold-open arm complete with red vinyl grip handle to permit easy release and one-hand control of the cover to its closed and latched position. All hardware shall be stainless steel. Gasket shall be extruded EPDM adhesive back seal and continuous around cover.
- F. Approved Model / Manufacturer: Type No. "S-50TB" Roof Scuttles (Hatches) for ladder access, or Architect approved equal.
- G. Roof Access Ladder: As specified in Section 05 50 00, Miscellaneous Metals. Ladder shall be oriented and mounted along the short dimension of the hatch.
- H. Fall Protection Safety Rail: 30"x36" Model SP 3036 [36"x36" Model SP 3036] by **SafePro L.C.** Guardrail height shall be 42" above finished roof surface. Color shall be powder coated safety yellow.
- I. Folding Fall Protection Safety Rail: Aluminum guardrail system [30"x36"] [36"x36"] Model by Precision Ladders LLC. Guardrail height shall be 42" above finished roof surface. Color shall be powder coated safety yellow.
- J. Telescoping Ladder Safety Post: Model ER-1 Extend-A-Rail Ladders Safety Post as manufactured by Precision Ladders LLC. 1.62" OD Schedule 40 anodized aluminum pipe post and 16"x4"x1/4" aluminum mounting plate. Provide with locking slot and knob. All mounting hardware shall be Type 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate installation of sealant and roofing cement with Work of this Section to ensure water tightness.
- B. Coordinate installation of components of this Section with installation of roof deck, roof structure, roofing membrane, and base flashing.
- C. Roof hatches and heat / smoke vents shall be welded to structural steel frame of building.
- D. Install hatches and heat / smoke vents in accordance with details on drawings, approved shop drawings, and manufacturer's instructions.
- E. Set units plumb, level, and true to line without warp or rack. Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.
- F. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a watertight and airtight seal.

3.2 FIELD QUALITY CONTROL

- A. Smoke Vent Testing: Test for proper operation after installation by one or all of the operational methods.
- B. Melting fusible link for inside at smoke vent level recommend using handheld propane tank torch. Replace fusible link, then close vents from the exterior at the roof top level.
- C. Pull internal and / or external manual pull handles and then close vents from the exterior at the roof top level.
- D. Do not paint the internal mechanisms, especially moving parts such as spring, dampers, rotary latches and especially the fusible links. Painting any of these components may damage the vents and will void the warranty.

3.3 ADJUSTING

- A. Adjust movable parts for smooth operation.
- B. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation

3.4 CLEANING

- A. Clean exposed surfaces per manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION 07 72 33

SECTION 07 92 00 - JOINT SEALANTS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Exterior sealants and sealants for moving and control joints.

1.2 RELATED WORK

- A. Masonry control and expansion joints.
- B. Sealants used in conjunction with roofing.
- C. Sheet Metal Flashing, Gutters, Downspouts and Trim: Sealants used in conjunction with sheet metal items.

1.3 REFERENCES

- A. ASTM International (ASTM)
 - 1. C717, Standard Terminology of Building seals and Sealants
 - 2. C793, Standard Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants
 - 3. C794, Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
 - 4. C834, Standard Specification for Latex Sealants
 - 5. C920, Standard Specification for Elastomeric Joint Sealants
 - 6. C1193, Standard Guide for Use of Joint Sealants
- B. Sealant, Waterproofing and Restoration Institute (SWRI)
 - 1. The Processional's Guide

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's specifications and other data needed to prove compliance with specified requirements.
 - 2. Manufacturer's installation instructions.
- B. Sample: On site sample for Architect's approval of colors.
- C. Certification: Manufacturer's affidavit that materials used in Project contain no asbestos.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Experienced in building sealant installation whose work has resulted in sealant installations with a record of successful performance.
- B. Source Limitations: Unless specifically indicated, obtain each type of building sealant through one source from a single manufacturer.
- C. Pre-construction Field Adhesive Testing: Prior to installation of building sealants, field test their adhesion to joint substrates in accordance with manufacturer's instructions.

Perform test in locations indicated by Architect. Perform test for each type of building sealant and each substrate as required by Architect. If required by Architect, arrange for tests to be performed with sealant manufacturer's representative present. Follow-up review by Architect and manufacturer may be required to observe sealant performance over time and may result in re-application of sealant or replacement.

- D. Cleaning: Facade sealants that have collected dirt at the time of Substantial Completion shall be cleaned over the entire facade prior to acceptance by the Owner. 11 months after final completion of the building, if the sealant joints show dirt, they shall again be cleaned over the entire façade.

1.6 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of sealants when joint substrates are wet or when ambient temperature conditions are above limits permitted by sealant manufacturers or are below 40 degree F.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of sealants until contaminates which may interfere with adhesion are removed from substrates.

1.7 PRE-INSTALLATION CONFERENCE

- A. Refer to Section 01 31 13 – Project Coordination.
- B. In addition, refer to information above concerning Field Adhesive Testing.

1.8 WARRANTY

- A. Warrant the work specified herein for two (2) years against becoming unserviceable or causing an objectionable appearance resulting from either defective or nonconforming materials and workmanship.
- B. Defects shall include, but not be limited to:
1. Leaking
 2. Cracking, splitting or releasing from substrate
 3. Deterioration or color change

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Specifications are based on the products or materials of the named manufacturer, otherwise selection may be made from any manufacturer listed below whose products meet or exceed the specifications. Other manufacturers must have a minimum of five (5) years' experience manufacturing the products meeting or exceeding the specifications and comply with Division 1 requirements regarding substitutions to be considered.
1. Typical Sealants:
 - a. Sika
 - b. Dow Corning
 - c. General Electric Co.
 2. Silicone Sealants at Appliances:
 - a. Sika

- b. Dow Corning
- c. General Electric Co.

2.2 MATERIALS

- A. Caulking for Exposed Non-Working Interior Locations:
 - 1. Type: Acrylic Latex, conforming to ASTM C834; single component, paintable.
 - 2. Applications: Use for interior wall and ceiling joints, joints between door and window frames and wall surfaces, and other interior non-traffic-bearing joints for which no other type of sealant is indicated.
- B. Sealant for Working Joints and Exposed Vertical Exterior Locations:
 - 1. Type: Polyurethane, conforming to ASTM C920, Type S or M, Grade NS, Class 35; single or multi-component, non-sagging.
 - 2. Applications: Use for:
 - a. Control, expansion, and soft joint masonry. Refer to drawings and Section 04 20 00, Unit Masonry for specific locations. Provide full sealant joints at building expansion joints.
 - b. Joints between concrete and other materials.
 - c. Joints between metal frames and other materials.
 - d. Other exterior non-traffic-bearing joints for which no other type of sealant is indicated.
- C. Rubber Sealant:
 - 1. Type: Butyl sealant, conforming to ASTM C920, Type NT, Grade NS, Class 12-1/2; single component, solvent release, non-skinning, non-sagging.
 - 2. Movement Capability: Plus and minus 12-1/2 percent.
 - 3. Service Temperature range: -13 to 180 degree F.
- D. Silicone Sealant: ASTM C 920, Type S, Grade NS, Class 50, use NT.
 - 1. Use: Precast Concrete Joints between metals, glass, and plastics (Single component sealants).
 - 2. Properties: Performance: Non-staining, non-bleeding, and non-streaking to sealed and adjacent substrates.
 - 3. Cure System and Oil Content: Neutral Cure System specifically manufactured with controlled oil content to eliminate oil migration into sealed substrates and residue rundown over and onto adjacent substrates.
 - 4. Product and Manufacturer:
 - a. Sika Corporation, Construction Products Division; SikaSil-C995.
 - b. Dow Corning Corporation; 756 SMS, 791, 795, 995 as applicable.
 - c. GE Advanced Materials, Silicones; SilGlaze II SCS2800, SilPruf NB SCS9000, SilPruf SCS2000, or UltraPruf II SCS2900 as applicable.
- E. Primers, Cleaners, Top Coats: Use only materials listed as suitable in resistance to staining, compatibility and durability before proceeding.
- F. Expanded Polyethylene Joint Filler: Provide flexible, compressible, closed-cell, polyethylene of not less than 10 psi compression deflection (25 percent); except provide higher compression deflection strength as may be necessary to withstand installation forces and provide proper support for sealants, surface water absorption of not more than 0.1 pounds per square foot, as manufactured by Sonneborn, or pre-approved equal.

- G. Sealant Backer Rod: Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable, non-absorptive material as recommended by sealant manufacturer for back-up of and compatibility with sealant. Where used with hot-applied sealant, provide heat-resistant type, which will not be deteriorated by sealant application temperature as indicated.
- H. Bond Breaker Tape: Provide polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Temperatures: Do not install sealants when air temperature is under 40 degrees F. Sealants may be warmed to ease installation when recommended by the manufacturer.
- B. Tooling: Tool exposed joints to a slightly concave surface using slicking materials recommended by the manufacturer. The tooling procedure shall press sealant against the sides of the groove. No materials shall be left "feathered" out or smeared on the abutting materials. If necessary, protect adjacent surfaces with tape. Completed joints shall have a uniform professional appearance. Use an anti-tack compound on sealant that does not set up fast enough to avoid dust collection.
- C. Sealant Back-Up: Provide back-up filler where groove depth is too great to fill with sealant. Review joint design with Architect.
- D. Compressive Filler: Seal vertical expansion joints with fillers. Provide compressible filler twice the width of the joint and with a depth of 1-1/2 times the compressed width. Lap ends 2 inch minimum.
- E. Seal ends together in such a manner to allow natural drainage. Install filler by compressing material and sliding into joint. Align filler on one face of the joint before it expands to the full joint width.

END OF SECTION

SECTION 07 95 22 – EXPANSION JOINTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Requirements including but not limited to:
 - 1. Expansion joints.
 - 2. Accessories necessary for a complete installation.

1.3 RELATED SECTIONS

- A. Section 07 52 20 – Mod Bit Cool Roof Membrane.
- B. Section 07 52 23 – Adhered PVC Decor.

1.4 SUBMITTALS

- A. Product Data: Technical data for each type of product including construction details, material descriptions, dimensions of individual components and profiles, and finishes for expansion joint cover assemblies.
- B. Shop Drawings: Submit for each expansion joint cover assembly.
 - 1. Include plans, elevations, sections, details, splices, block out requirement, attachments to other work, and line diagrams showing entire route of each expansion joint.
 - 2. Where expansion joint cover assemblies change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
- C. Sample: Sample of material is required at time of submittal.
- D. Product Test Reports: For each fire resistance rated expansion joint cover assembly, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Fire Resistance Ratings: Provide expansion joint cover assemblies with fire barriers identical to those of systems tested for fire resistance according to UL 2079 or ASTM E 1966 by a qualified testing agency.
 - a. Hose Stream Test: Wall-to-wall and wall-to-ceiling assemblies shall be subjected to hose stream testing.
- B. All products must be certified by independent laboratory test report to be free in composition of any waxes or wax compounds using FTIR and DSC testing.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backings, and other related materials compatible with one another and with joint substrates under conditions of service and application, demonstrated by testing performed by joint sealant manufacturer, based on testing and field experience.
- B. Sealants: Use self-leveling compounds for horizontal joints in pavements and nonsag compounds elsewhere except as shown or specified.
- C. Colors: For 100% concealed joints, provide color of sealant which has the best overall performance characteristics for the application shown. For exposed joints provide colors selected by Architect to match adjacent material colors.
 - 1. Exterior window and curtain wall framing, each color.
 - 2. Exterior window framing, each color.
 - 3. Architectural precast concrete, each color.
 - 4. Face brick, each color.
 - 5. Decorative masonry units, each color.
 - 6. Cast stone, each color.
 - 7. Stone cladding, each color.
 - 8. Metal panels, each color.
 - 9. Exterior insulation finish system, each color.
 - 10. Exterior field applied paints and coatings, each color.
 - 11. Other exterior and interior materials, each color as indicated.
- D. Silicone Joint Sealants
 - 1. Silicone: Pre-coated, preformed, pre-compressed, self-expanding, sealant system. Expanding foam to be cellular foam impregnated with a water-based, non-drying, 100% acrylic dispersion. Material capable of movements of +50%, -50% (100% total) of nominal material size.
 - a. Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
 - b. Joint Locations:
 - 1) Construction joints in cast in place concrete.
 - 2) Joints between plant precast architectural concrete units.
 - 3) Control and expansion joints in unit masonry.
 - 4) Joints in dimension stone cladding.
 - 5) Joints in glass unit masonry assemblies.
 - 6) Joints in exterior insulation and finish systems.
 - 7) Joints between metal panels.
 - 8) Joints between different materials listed above.
 - 9) Other joints as indicated on Drawings.
 - c. Color: Selected by Architect.
 - d. Basis of Design Manufacturer: Seismic Colorseal as manufactured by Emseal Joint Systems. Other manufacturers are subject to compliance with requirements.
- E. Miscellaneous Materials:
 - 1. Primer: Material recommended by sealant manufacturer where required for adhesion of sealant to joint substrates indicated, determined from preconstruction sealant substrate tests and field tests.
 - 2. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

3. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and conditions affecting performance of the work. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with sealant manufacturer's written instructions and the following requirements:
 1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Remove laitance and form release agents from concrete.
- B. Joint Priming: Prime joint substrates where recommended by sealant manufacturer or as indicated by preconstruction sealant substrate tests or prior experience. Apply primer to comply with sealant manufacturer written instructions. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

- A. Joint Sealants: Comply with sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Sealant Backing: Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
 4. Install bond breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
 5. Install weeps and vents into joints at the same time sealants are being installed. Unless otherwise shown, locate weeps and vents spaced as recommended by the sealant manufacturer and the window and curtain wall fabricator and erector. Do not install weeps and vents at outside building corners. Do not install vents at horizontal joints immediately below shelf angles, sills, and through wall flashings.

- D. Sealants: Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants to directly contact and wet joint substrates.
 2. Completely fill recesses in each joint configuration.
 3. Produce uniform, cross sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 4. Apply sealants to depth shown and in accordance with the manufacturer's recommendations and the following proportions and limitations:
 - a. Apply elastomeric sealants in horizontal joints to a depth equal to 75% of the joint width, but not less than 3/8 inch (10 mm) and not more than 3/4 inch (19 mm).
 - b. Apply elastomeric sealants, in joints not subject to traffic or other abrasion, to a depth equal to 50% of the joint width, but not less than 1/4 inch (6 mm) and not more than 1/2 inch (13 mm).
 - c. Apply nonelastomeric sealants to a depth approximately equal to the joint width.
 - d. Fill horizontal traffic bearing joints slightly recessed to avoid direct contact with wheel, and pedestrian traffic. Fill horizontal traffic bearing joints with slope grade polyurethane sealants to a depth approximately equal to the joint width.
 5. Pour self-leveling sealants to a depth approximately equal to the joint width.
- E. Tooling of Non sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint.
1. Use masking tape to protect adjacent surfaces of recessed tooled joints.
 2. Remove excess sealant from surfaces adjacent to joints.
 3. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 4. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.
 5. Provide flush joint profile at locations indicated on Drawings according to Figure 8B in ASTM C 1193.
 6. Provide recessed joint configuration of recess depth and at locations indicated on Drawings according to Figure 8C in ASTM C 1193. Use masking tape to protect surfaces adjacent to recessed tooled joints.
 7. Provide slight wash on horizontal joints where horizontal and vertical surfaces meet.
 8. At rough surfaces or in joints of uneven widths, avoid appearance of excess sealant or compound by locating the compound or sealant back into joint wherever possible.
- F. Preformed Silicone Sealant System:
1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
 2. Apply a bead of silicone sealant to each side of joint to produce a bead of size complying with preformed silicone sealant system manufacturer's printed schedule and covering a bonded area of not less than a 3/8 inch (10 mm). Hold edge of sealant bead inside of masking tape by 1/4 inch (6 mm).
 3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
 4. Complete installation of horizontal joints before installing vertical joints. Lap vertical joints over horizontal joints. At end of joints, cut silicone extrusion with a razor knife.
- G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, to produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant to comply with sealant manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

- A. Field Adhesion Testing: Field test sealant adhesion to joint substrates:
1. Extent of Testing: Test completed and cured sealant joints as follows:
 - a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
 - b. Perform one test for each 1000 feet (300 m) of joint length thereafter or one test per each floor per elevation.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. Make knife cuts from one side of joint to the other, followed by two cuts approximately 3 inches (75 mm) long at sides of joint and meeting cross cut at one end. Place a mark 1 inch (25 mm) from cross-cut end of 3 inch (75 mm) piece.
 - b. Use fingers to grasp 3 inch (75 mm) piece of sealant between cross cut end and 1 inch (25 mm) mark; pull firmly at a 90 degree angle to the joint in the direction of side cuts and hold the sealant in position for 10 seconds; following the 10 second time duration pull sealant at a 180 degree angle parallel to the joint and hold the sealant in this position for 10 seconds. Pull sealant away from joint to the distance recommended by sealant manufacturer for testing adhesion.
 - c. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
 - d. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer field adhesion hand pull test criteria.
 4. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean excess sealant or sealant smears adjacent to joints as the work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 95 22

SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide all work for mechanical, plumbing and fire protection systems required in the project to be properly installed, tested, and performing their intended function.

1.3 QUALITY ASSURANCE

- A. Perform all work in accordance with the latest edition of the applicable codes, specifications, local ordinances, industry standards, utility company regulations, nationally accepted codes.
- B. All materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new, unused and of United States Domestic manufacture unless approved otherwise by engineer or owner.
- D. Eliminate any abnormal sources of noise that are considered by the Architect or Engineer not to be an inherent part of the systems as designed without additional cost to the Owner.

1.4 COORDINATION WITH OTHER TRADES

- A. Coordinate the work of this division with all other divisions to ensure that all components of the mechanical, plumbing and fire protection system will be installed at the proper time and fit the available space.
- B. Locate and size all openings in work of other trades required for the proper installation of the mechanical, plumbing and fire protection system components.
- C. Make all mechanical, plumbing and fire protection connections to all equipment furnished by this division and as required by any other division.
- D. Electrical wiring, control equipment and motor starters indicated on the electrical drawings, except items otherwise specifically noted, shall be furnished, and installed by the electrical trades. Items of electrical control equipment specifically mentioned to be furnished by the mechanical trades, either in these specifications or on the mechanical drawings, shall be furnished, mounted, and wired by this trade unless where otherwise specified in Division 26 or noted on the electrical drawings to be by the electrical trades. All wiring shall be in accordance with all requirements of the electrical Sections of these specifications.
- E. Any changes or additions required by specific equipment furnished shall be the complete responsibility of the Contractor furnishing the equipment. All controllers furnished with mechanical equipment shall have overload protection in all phases. It shall be the responsibility of each subcontractor furnishing motors and devices to advise Electrical

Contractor of exact function of systems to assure proper type of starter with correct number auxiliary contacts for proper operation of the system.

- F. The mechanical trades shall coordinate with the electrical contractor to ensure that all required components of control work are included and fully understood. No additional cost shall accrue to the Owner as a result of lack of such coordination.
- G. The design of the electrical systems is based on the mechanical equipment scheduled and shown on the drawings. Where changes or substitutions are made that involve additional electrical work (larger-size motors, larger number of motors, additional wiring of equipment, etc.), the mechanical contractor shall be responsible for added cost and coordination with the electrical subcontractor. The mechanical contractor shall pay the electrical trades for the cost of the additional work and materials except for changes by addendum.
- H. Motor control equipment which is furnished loose under Division 23 shall be delivered to the Electrical Contractor at the site for custody, erection in place, and wiring as specified.
- I. Smoke detection systems will be furnished and installed under Division 26 – electrical. Coordinate locations with Electrical Contractor.

1.5 DRAWINGS

- A. The drawings are schematic in nature but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Determine exact locations by review of equipment manufacturer's data, by job site measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. The size of the mechanical, plumbing and fire protection equipment indicated on the Drawings may be based on the dimensions of a particular manufacturer. While other listed manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment that the Contractor proposes to furnish will fit in the space. The drawings are not intended to show exact locations of pipes and ducts, or to indicate all offsets and fittings or supports, but rather to indicate approximate layout.
- B. The mechanical, plumbing and fire protection Drawings are necessarily diagrammatic in character and cannot show every connection in detail in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid crippling of structural members. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical, electrical, plumbing and fire protection Drawings do not give exact details as to the elevation of pipe, conduit, and ducts, physically arrange the systems to fit in the space available at the elevations intended with the proper grades for the functioning of the system involved. Exposed piping and ductwork are generally intended to be installed true and square to the building construction and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets and their location details. Work shall be concealed in all finished areas.

1.6 SUBMITTALS

- A. Provide shop drawings and complete product data as indicated in each specification section.
- B. Coordination Drawings: Using the mechanical ductwork shop drawings as a basis, provide a composite set of AutoCAD drawings in which the major mechanical, plumbing and fire protection equipment, ductwork and piping are superimposed on the architectural reflected ceiling plan and structural framing plan. Include spot elevations of bottom of steel along with finished ceiling height. Prepare at 1/8-inch scale or larger, one drawing per building area. Provide 1/4-inch scale enlargements of locations where special attention to rough-in dimensions as required to ensure all systems will fit within the available space. Obtain approval of coordination drawings prior to duct fabrication and mechanical system hanger rough-ins.
- C. Shop Drawings will be reviewed and returned to the Contractor with one of the following categories:
 - 1. **Reviewed:** No further submittal action is required. Submittal to be included in O & M Manual.
 - 2. **Revise and Resubmit:** Contractor to resubmit submittal as indicated in comments section of Engineer's Submittal Cover Letter.
 - 3. **Rejected:** Contractor to resubmit new submittal when alternate or substitution is not approved and be required to furnish product named in Specification and or Drawings.
 - 4. **Furnish as Corrected:** Contractor to submit letter verifying that required corrections noted on Engineer's Submittal Cover Letter have been received and complied with by manufacturer. If equipment on site is not in compliance with corrections noted, contractor shall be responsible for the cost of removing and replacing equipment.
- D. Materials and equipment which are purchased or installed without Submittal review and approval will be removed and replaced with specified equipment at Contractor's expense.
- E. Provide a specification review that consists of a copy of related specification section with notations indicating compliance or deviation with each element of specification.

1.7 SUBSTITUTIONS OF PRODUCTS

- A. The products described in the Proposal Documents establish a standard of required function, dimension, appearance, and quality to be met by any proposed substitution. The materials and equipment named in, and the procedures covered by these specifications have been selected as a standard because of quality, particular suitability, or record of satisfactory performance. It is not intended to preclude the use of equal or better materials or equipment provided that same meets the requirements of the particular project and is approved in an Addendum as a substitution prior to the submission of proposals.
- B. No substitution will be considered prior to receipt of proposals unless written request for approval has been received by the Architect and Engineer at a minimum of seven (7) business days prior to the date for receipt of proposals. Each such request shall include a specification line by line review annotated to certify compliance, the name of the

manufacturer and model, material or equipment for which it is to be substituted and a complete description of the proposed substitute including dimensional drawings, cutsheets, performance and test data and any other information necessary for an evaluation. The Engineers decision of approval or disapproval of a proposed substitution shall be final.

- C. If the Engineer approves any proposed substitution prior to receipt of proposals, such approval will be set forth in an Addendum. Offerors shall not rely upon approvals made in any other manner.
- D. The Engineer and Owner reserve the right to disapprove the use of any manufacturer who in their judgment is unsuitable for use on the Project and that decision will be final.
- E. Availability of specified items:
 - 1. Verify prior to submittal of Proposal that all specified items will be available in time for installation during orderly and timely progress of the work.
 - 2. In the event specified items will not be so available, notify the Architect / Engineer prior to receipt of Proposals. Submit Request for Substitutions in accordance with this section.
 - 3. The request will not be considered if the product or method cannot be provided as a result of the Contractor's failure to pursue the work promptly or coordinate activities properly.
 - 4. Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.
- F. A request constitutes a representation that Offeror:
 - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
 - 2. Will provide same warranty for Substitution as for specified product, except when inability to provide specified Warranty is reason for request for substitution as described above.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 5. Will reimburse the Owner and pay for all costs, including Architect/Engineer's redesign and evaluation costs resulting from the use of the proposed substitution, or for review or redesign services associated with re-approval by authorities having jurisdiction.
- G. **No substitutions will be considered after the Award of Contract.**

1.8 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Division 1 - General Requirements and each specification section.

1.9 INTERFERENCE DRAWINGS

- A. Where field conditions prohibit the installation of the mechanical, plumbing or fire protection system components within the available space as indicated on drawings, the Contractor shall prepare a sketch to the minimum 1/8-inch scale, clearly depicting the conflict along with an alternate installation arrangement that satisfies the design intent of the documents without incurring additional cost.
- B. Obtain written approval of proposed interference resolution prior to proceeding with alternate installation.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Equipment listed below shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. Contractor shall adequately protect equipment such as but not limited to: Chillers, Air Handling Units, Fan coil Units, Roof top Units, Air Terminal Units, Boilers, Pumps, Air Devices, exhaust fans, variable frequency drives, ductwork, duct insulation, piping insulation, hydronic piping, air duct accessories, unit heaters, etc. from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging; original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.
- D. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- E. Protect units from physical damage. Leave factory covers in place until startup of machine.

1.11 GENERAL ELECTRICAL REQUIREMENTS

- A. Provide electric motors, control panels, certain control and safety devices and control wiring when specified or required for proper operation of electrical systems associated with mechanical equipment specified in Division 23.
- B. Electrical materials and work provided shall be in accordance with Division 26.

- C. Notify Architect/Engineer in writing 14 days before bids are due if it is necessary to increase horsepower of any motors or change any electrical requirements listed or shown. After this period, costs incurred because of changes shall be assumed by the responsible Contractor.

1.12 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

- A. Mechanical equipment with factory assembled and/or attached electric equipment shall be Underwriters' Laboratories (UL) listed as an assembly when such listing is available from UL and shall meet the latest edition of the National Electrical Code.
- B. Unless otherwise specified, the electrical supply being furnished is a 460-volt, 3 phase, 3 wire, 60 hertz source. No neutral connection is available from the 460-volt source. The manufacturer shall include any transformers for equipment requiring other voltages (277volt, 220-volt, 120-volt, 24 volt, etc.).
- C. Electric Motors:
 - 1. For each piece of equipment requiring electric drive, provide a motor having started and running characteristics consistent with torque and speed requirements of the driven machine.
 - 2. Manufacturers furnishing motors shall verify motor horsepower with the characteristic power curves of driven equipment on shop drawings.
 - 3. Each motor shall be furnished in accordance with Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
 - 4. Contractor shall verify electrical characteristics of each motor with electrical drawings.
 - 5. Motors which are shipped loose from equipment shall be set by supplying subcontractor.
 - 6. Alignment of motors factory coupled to equipment and motors field coupled to equipment shall be rechecked by millwright after all connections (belt drives, gear drives, impellers, piping, etc.) have been completed and again after 48 hours of operation in designed service.
 - 7. Where possible, motors shall be factory mounted.

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OWNER INSTRUCTION - GENERAL

- A. Installing Contractor shall coordinate and provide on-site Owner training for all new equipment by factory trained specialists for all Mechanical and Plumbing equipment in two (2) separate training meetings. One (1) training session shall be prior to Owner's acceptance and occupancy, and the other training session shall occur (30) thirty days later. Sign-in sheets are required for both meetings and shall be included in close out submittals.

- B. Use Operation and Maintenance manuals and actual equipment installed as basis for instruction.
- C. At conclusion of on-site training program have Owner personnel sign written certification they have completed training and understand equipment operation. Include copy of training certificates in final Operation and Maintenance manual submission.
- D. Refer to individual equipment specifications for additional training requirements.

END OF SECTION 23 05 00

SECTION 23 05 14 - VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. The drive shall be designed specifically for variable torque applications. It is required that the drive manufacturer has an existing independent service organization.
- B. The drive and all necessary controls as specified herein shall be supplied by the drive Manufacturer. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten (10) years.
- C. For Air Handling Units with multiple fans (Fan Array) and motors, VFD manufacturer shall provide internal individual motor overloads to match quantity of fan motors. Refer to Air Handling Unit Schedule for fan motor quantity

1.3 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronic Engineers (IEEE)
 - a. Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - 2. Underwriter's laboratories
 - a. UL508C
 - 3. National Electrical Manufacturer's Association (NEMA)
 - a. ICS 7.0, AC Adjustable Speed Drives
 - 4. IEC 16800 Parts 1 and 2
- B. Testing:
 - 1. All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a computerized systems test (cold), burn-in, and computerized systems test (hot). The burn-in shall be at 104 degrees Fahrenheit at full rated load, on a motor. Drive input power shall be continuously cycled for maximum stress and thermal variation.
 - 2. All testing and manufacturing procedures shall be ISO 9001 certified.
- C. Failure Analysis:

1. VFD manufacturer shall have an analysis laboratory to evaluate the failure of any component. The failure analysis lab shall allow the manufacturer to perform complete electrical testing, x-ray of components, and decap or delaminate of components and analyze failures within the component.

D. Qualifications:

- a. VFD's and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable.

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Submit VFD's only after coordination with approved Air Handling Units, Pumps, and Cooling Tower Submittals (If applicable).
- C. All Variable Frequency Drives serving various equipment such as but not limited to: Air handling Units, Pumps and Cooling towers shall be supplied by the same manufacturer.
- D. Submittals shall include, as a minimum, the following information:
 1. Outline Dimensions
 2. Weight
 3. Compliance to IEEE 519 - harmonic analysis for particular job site including total harmonic voltage distortion and total harmonic current distortion.
 - a. The VFD manufacture shall provide calculations specific to the installation, showing total harmonic voltage distortion is less than five (5) percent. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519 (latest version), guide for Harmonic Control and Reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior VFD installation.
 - b. If the voltage THD exceeds five (5) percent, the VFD manufacturer is to recommend the additional equipment required to reduce the voltage THD to an acceptable level.

1.5 WARRANTY

- A. The warranty shall be (2) two years and shall begin from date of Certificate of Substantial Completion. The warranty shall include all parts, labor, travel time and expenses to provide on-site warranty.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's original, unopened containers with identification labels intact.

- B. The contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.7 MANUFACTURERS

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. ABB – Basis of Design
 - 2. Danfoss.
 - 3. Yaskawa.

PART 2 - PRODUCTS

2.1 ADJUSTABLE FREQUENCY DRIVES

- A. The adjustable frequency drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output. The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure (NEMA 3R if outdoors or unconditioned space), completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), Integral Line Reactor(s), Capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
 - 1. Input 480 VAC +/- 10 percent, 3 phase, 48-63 Hz. The overvoltage trip level shall be 30 percent over the nominal, and the under-voltage trip level shall be 35 percent over the nominal voltage as a minimum.
 - 2. Output Frequency 0 to 250 Hz. Operation above 60 Hz shall require programming changes to prevent inadvertent high-speed operation.
 - 3. Environmental operating conditions: 0 to 104 Degree Fahrenheit, 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing.
 - 4. Conditioned indoors enclosure shall be rated NEMA 1 and shall be UL listed as a plenum rated drive. Drives without this rating are not acceptable.
 - 5. VFD's located in un-conditioned spaces or outdoors shall have rated NEMA 4X enclosure and shall be UL listed as a plenum rated drive. Drives without this rating are not acceptable.
- B. All VFD's shall have the following features:

1. All VFD's shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad is to be used for local control, for setting all parameters, and for stepping through the displays and menus. The keypad shall be removable, capable of remote mounting, and shall have its own non-volatile memory. The keypad shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.
2. The keypad shall include Hand-Off-Auto membrane selections. When in "Hand", the VFD will be started, and the speed will be controlled from the up/down arrows. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure and the VFD speed will be controlled via an external speed reference. The drive shall incorporate "bump less transfer" of speed reference when switching between "Auto" and "Hand" modes and vice-versa.
3. The VFD's shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to ACS400-US-reprogram all parameters and customer interfaces for a particular application to reduce programming time.
4. The VFD shall have the ability to automatically restart after an over current, overvoltage, under voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
5. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start). The VFD shall also be capable of DC injection braking at start to stop a reverse spinning motor prior to ramp.
6. The VFD shall be equipped with an automatic extended control power loss ride-through circuit, which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Typical control power loss ride-through for a fan load shall be 2 seconds minimum.
7. If the input reference (4-20mA or 2-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communication bus.
8. The customer terminal strip shall be isolated from the line and ground.
9. The drive shall employ current limit circuits to provide trip free operation:
 - a. The Slow Current Regulation limit circuit shall be adjustable to 150 percent (minimum) of the VFD's normal duty current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
 - b. The Current Switch-off limit shall be fixed at 350 percent (minimum, instantaneous) of the VFD's normal duty current rating.

10. The overload rating of the drive shall be 110 percent of its normal duty current rating for one (1) minute in every ten (10) minutes. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430-150 for 4-pole motors.
11. The VFD shall have an integral Line Reactor(s) to reduce the harmonics to the power line and to increase the fundamental power factor. The minimum impedance shall be three (3) percent.
12. The VFD shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay outputs shall include programmable time delays that will allow for drive acceleration from zero speed without signaling a false under load condition.
13. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.
14. A complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
15. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector
 - c. Bypass mode selector
 - d. Bypass fault reset
16. The following indicating lights (LED type) shall be provided:
 - a. Power-on
 - b. External fault
 - c. Drive mode selected
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Automatic transfer to bypass selected
17. Customer Interlock Terminal Strip: Provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All

external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes.

18. The following relay (form C) outputs from the bypass shall be provided.
 - a. Drive run
 - b. Bypass run
 - c. Drive fault Bypass fault (motor overload or under load (broken belt)
19. Automatic or manual bypass (field selectable)
20. Manual or automatic bypass fault (field selectable)
21. Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure.
22. Door interlocked pad lockable circuit breaker which will disconnect all input power from the drive and all internally mounted options.
23. Fast acting semi-conductor fuses exclusive to the VFD - fast acting semi-conductor fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the Bypass will not be accepted.
24. Class 10 or 20 (selectable) electronic motor overload protection shall be included in the microprocessor bypass to protect the motor in bypass mode.

C. All VFD's to have the following adjustments:

1. Two (2) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed.
2. PID Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control. The VFD shall have 250 mA of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The auxiliary power supply shall have overload and over current protection. The PID setpoint shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.
3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PID controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 ma and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz. Process variables shall be modifiable by math functions such as multiplication and division between the two signals (fan tracking), high/low select, as well as inverted follower.
4. Five (5) programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety

connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock) drive is to resume normal operation.

5. One (1) programmable analog output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data.
 6. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable. Relays shall be capable of programmable on and off delay times.
 7. Seven (7) programmable preset speeds.
 8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
 9. The VFD shall Ramp or Coast to a stop, as selected by the user.
- D. The following operating information displays shall be standard on the VFD digital display. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of two operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Speed (RPM, percent, or Engineering units)
 3. Motor Current
 4. Calculated Motor Torque
 5. Calculated Motor Power (kW)
 6. DC Bus Voltage
 7. Output Voltage
 8. Heat sink Temperature (0°F)
 9. Analog Input Values
 10. Analog Output Value
 11. Keypad Reference Values
 12. Elapsed Time Meter (resettable)
 13. kWh meter (resettable)
 14. mWh meter
 15. Digital input status

16. Digital output status
- E. The VFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alphanumeric codes are not acceptable).
1. Over current trip 350 percent instantaneous (170 percent RMS) of the VFD's variable torque.
 2. Current rating.
 3. Overvoltage trip 130 percent of the VFD's rated voltage.
 4. Under voltage trip 65 percent of the VFD's rated voltage.
 5. Over temperature +90 degrees Celsius.
 6. Ground Fault either running or at start.
 7. Adaptable Electronic Motor Overload (1 2 t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits, which are not speed dependant, are unacceptable. The electronic motor overload protection shall be UL approved for this function.
- F. Speed Command Input shall be via:
1. Keypad.
 2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal.
 3. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.
 4. Serial Communications
- G. Serial Communications
1. The VFD shall have an RS-485 port as standard. The standard protocol shall be BACnet. Optional protocols that must be available are Johnson Controls N2 bus, Siemens Building Technologies FLN, LonWorks, Profibus and DeviceNet.
 2. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The drive shall allow the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), percent torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote (LAN) VFD fault reset shall be possible. A minimum of 15 field parameters shall be capable of being monitored.
 3. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. The serial communications interface shall allow for DO (relay) control and AO (analog) control. In addition, all drive digital and analog inputs shall be capable of being monitored by the DDC system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive-in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- B. Power wiring shall be completed by the electrical contractor. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

3.3 PRODUCT SUPPORT

- A. Factory trained application engineering and service personnel that are thoroughly familiar with drive products offered shall be locally available at both the specifying and installation locations.

END OF SECTION 23 05 14

SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pressure gages.
 - 2. Pressure gage taps.
 - 3. Stem type thermometers.
 - 4. Dial thermometer.
 - 5. Thermometer supports.
 - 6. Test plugs.
 - 7. Bladder-type expansion tanks.
 - 8. Air vents.
 - 9. Combination Dir and Air Separators.
 - 10. Strainers.
 - 11. Flow controls.
 - 12. Relief valves.
- B. Related Sections:
 - 1. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: Submit for manufactured products and assemblies used in this Project.
 - 1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
 - 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
 - 4. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and instrumentation.
- B. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.8 WARRANTY

- A. Furnish one (1) year manufacturer warranty for piping specialties.

PART 2 - PRODUCTS

2.1 PRESSURE GAGES

- A. Manufacturers:
 - 1. Weiss
 - 2. Marsh Bellofram
 - 3. Weksler
 - 4. Dwyer
- B. Gage: ASME B40.1, UL 404 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Stainless steel.
 - 2. Bourdon Tube: Phosphor bronze.
 - 3. Dial Size: 4-1/2 diameter.
 - 4. Mid-Scale Accuracy: One (1) percent.

5. Scale: Psi.

2.2 PRESSURE GAGE TAPS

A. Manufacturers:

1. Weiss
2. Marsh Bellofram
3. Weksler
4. Pete's Plug
5. Schrader

B. Needle Valve: Brass, 1/4-inch NPT for minimum 300 psi.

C. Ball Valve: Brass 1/4-inch NPT for 250 psi.

D. Pulsation Damper: Pressure snubber, brass with 1/4-inch NPT connections.

E. Siphon: Brass, 1/4-inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Terice
2. Weiss

B. Thermometer: Rigid 90°F angle, blue colored, organic, mercury fill, Valox case, brass stem, 1/2 NPT brass thermowell, acrylic window, lens front, magnifying tube type, scale face of aluminum, white background with black graduations and markings

1. Scale Size: 5-1/2" long.
2. Molded Valox - V-shaped black case.
3. Window: Double Strength Glass
4. Stem: Brass, 1/2-inch NPT, and 2 inches long.
5. Accuracy: $\pm 2\%$ of full scale ASME B40.4 Grade A.
6. Calibration: Both degrees Fahrenheit and degrees Celsius.

2.4 DIAL THERMOMETERS

A. Manufacturers:

1. Terice
2. Weiss

B. Thermometer: 300 stainless steel, hermetically sealed, bimetallic, silicone dampened on ranges to 300°F coil, adjustable angle, 1/2 NPT, double strength glass window, balanced, black finish pointer, dial face of aluminum, white background with black and blue graduations and markings.

1. Dial Size: 5-inch diameter dial.

2. Window: Double strength glass.
3. Stem: 300 Stainless Steel, 1/4" diameter NPT, 2-1/2" long.
4. Length of Capillary: Minimum five (5) feet.
5. Accuracy: $\pm 1\%$ of full scale ASME B40.4 Grade A.
6. Calibration: Both degrees Fahrenheit and degrees Celsius.

2.5 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions, and with cap and chain.
- B. Flange: Three (3) inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

- A. Manufacturers:
 1. Pete's Plug
- B. 1/4-inch NPT or 1/2-inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
 1. Neoprene core for temperatures up to 200 degrees F.
- C. Test Kit:
 1. Carrying case, internally padded and fitted containing:
 - a. One 2-1/2 inch 3-1/2-inch diameter pressure gages.
 - b. Two gage adapters with 1/8-inch probes.
 - c. Two 1-1/2-inch dial thermometers.

2.7 BLADDER-TYPE EXPANSION TANKS

- A. Manufacturers:
 1. Wheatly
 2. Bell and Gossett
 3. Wessels
 4. Armstrong
- B. Tank: Welded steel, rated for maximum 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 1. Size: As indicated on Drawings.
- C. Bladder: Heavy duty butyl-FDA approved.

- D. Gage Glass Set: Brass compression stops, guard, and 3/4-inch red line glass, maximum 24 inches length, long enough to cover tank for two (2) inches above bottom to two (2) inches below top.
- E. Quick Connect Air Inlet:
 - 1. Expansion Tank: Inlet tire check valve, manual air vent, tank drain, and pressure relief valve.
- F. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check back flow prevention device, test cocks, strainer, vacuum breaker, and by-pass valves.
- G. Hot Water Heating System:
 - 1. Select expansion tank pressure relief valve at 20 psi maximum.
 - 2. Set pressure reduction valve at select 12 psi.
- H. Chilled Water System:
 - 1. Select expansion tank pressure relief valve at 25 psi maximum.
 - 2. Set pressure reduction valve at 12 psi.
- I. Do not insulate ASME stamp and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

2.8 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong
 - 2. ITT
 - 3. Sarco
- B. Manual Type: Short vertical sections of two (2) inch diameter pipe to form air chamber, with 1/8-inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- D. Washer Type:
 - 1. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.

2.9 COMBINATION DIRT AND AIR SEPARATORS

- A. Manufacturers:

1. Bell and Gossett
 2. Armstrong
 3. Wessels
 4. Thrush
- B. Dip Tube Fitting: For 125 psig operating pressure; to prevent free air collected in boiler from rising into system.
- C. Dirt & Air Separator: Each separator must be designed with a blow-down valve, skim valve, and automatic air vent. The separator must also utilize in its design a stainless-steel coalescing medium to aid in the separation of air and dirt in the system entrained water. The separator must be constructed in accordance with the latest revision of the ASME Boiler and Pressure Vessel Code and stamped for 125 psi working pressure.

2.10 STRAINERS

- A. Manufacturers:
1. Bell and Gossett
 2. Keckley
 3. Armstrong
 4. Mueller
- B. Size two (2) inch and Smaller:
1. Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32-inch stainless steel perforated screen.
- C. Size 2-1/2 inch to four (4) inch:
1. Flanged iron body for 175 psig working pressure, Y pattern with 3/64-inch stainless steel perforated screen.
- D. Size five (5) inch and Larger:
1. Flanged iron body for 175 psig working pressure, basket pattern with 1/8-inch stainless steel perforated screen.

2.11 FLOW CONTROLS / BALANCING VALVES (COIL KITS) – ½" to 2" PIPE SIZE

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
1. TA / Victaulic
- B. 2" and smaller: 300 psi threaded or sweat ends, non-ferrous Ametal® brass copper alloy body, EPDM O-ring seals. 4 turn digital readout hand wheel for balancing, hidden memory feature with locking tamper-proof setting. Victaulic / Tour and Anderson Series balancing valve 787 (threaded) or Series 786 (Sweat). Suitable for operating temperatures to 250°F.

- C. Calibration: Factory set to control flow within three (3) percent of design flow over entire operating pressure.
- D. Accessories: In-line strainer on inlet and ball valve on outlet.
- E. Victaulic coil hookup packages for ½"- 2" shall include a Victaulic/TA valve style 78k; 787 or 786 connection and the following two components: 78U, 78Y. The Victaulic balancing valve shall be sized to flow, and all components shall be from one manufacturer, Victaulic. Victaulic 78U Union Port Fitting: 1/2" through 2" by Sizes: 400 psi maximum, Sweat/Soldered or FPT threaded x Union ends, DZR forged brass body with manual air vent port and pressure/temperature port, with EPDM seals. Union port fitting shall provide a simplified terminal hookup for installation at coil outlets. Suitable for operating temperatures up to 250°F. Victaulic series 78Y Strainer Ball Valve combination ½" through 2" up to 400psi Ametal copper alloy body consisting of a full port ball valve and strainer with pressure and temperature measuring ports. Ball valve shall be complete with Teflon packing, plated ball, blow-out proof stem, and steel handle with vinyl grip. Strainer shall be Y-pattern, with 20 mesh stainless steel screen and blowdown port.
- F. **All handles and pressure / sensor ports shall have extended stems to accommodate insulation.**
 - 1. Accessories: Test Kit.
 - 2. Carrying case, internally padded, and fitted containing:
 - a. One 2-1/2 inch 3-1/2-inch diameter pressure gages.
 - b. Two gage adapters with 1/8-inch probes.
 - c. Two 1-1/2-inch dial thermometers.
- G. Coil Hook up Packages: Victaulic Series 799 including 78u air vent union fittings with extended probe sets with minimum 2" of clearance and 78y strainer/ball valves combination with extended handle and probe set with minimum 2" of clearance. Coordinate with manufacture to confirm insulation clearance. No flex hoses shall be used.

2.12 FLOW CONTROLS – 2-1/2" AND LARGER PIPE SIZE

- A. Acceptable Manufacturers:
 - 1. Nibco.
- B. Construction: Ametal® Brass or bronze body, y-pattern, with union on inlet, and outlet, temperature and pressure test plug on inlet and outlet combination blow-down and back-flush drain.
- C. Calibration: Factory set to control flow within five (5) percent of design flow over entire operating pressure.
- D. Control Mechanism: Stainless steel or nickel-plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.13 RELIEF VALVES

- A. Manufacturers:
 - 1. Bell and Gossett
 - 2. McDonnell-Miller
- B. Bronze body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION - THERMOMETERS AND GAGES

- A. Install pressure gages for each pump, locate taps before strainers and on suction and discharge of pump, pipe to gage.
- B. Install gage taps in piping with isolation valves.
- C. Install pressure gages with pulsation dampers. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometers in air duct systems on flanges.
- F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- G. Locate duct-mounted thermometers minimum ten (10) feet downstream of mixing-dampers, coils, or other devices causing air turbulence.
- H. Coil and conceal excess capillary on remote element instruments.
- I. Install static pressure gages to measure across filters and filter banks, (inlet to outlet). On multiple banks, provide manifold and single gage.
- J. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- K. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- L. Adjust gages and thermometers to final angle, clean windows, and lenses, and calibrate to zero.

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Locate test plugs adjacent to pressure gages and pressure gage taps and as indicated on Drawings.
- B. Install manual air vents at system high points.
- C. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
- D. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E. Provide drain and hose connection with valve on strainer blow down connection.
- F. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- G. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- H. Support pump fittings with floor mounted pipe and flange supports.
- I. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- J. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Equipment relief valve capacity not to exceed rating of connected equipment.
- K. Pipe relief valve outlet to nearest floor drain.
- L. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 23 05 19

SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Globe valves.
 - 2. Ball valves.
 - 3. Plug valves.
 - 4. Butterfly valves.
 - 5. Swing check valves.
 - 6. Spring loaded check valves.
 - 7. Flanges and unions.

1.3 SUBMITTALS

- A. Product Data: Submit Manufacturers catalog information with valve data and ratings for each service.
- B. Welders Certificate: Include welder's certification of compliance with ASME Section IX.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves.
- B. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not install valves underground when bedding is wet or frozen.

1.8 WARRANTY

- A. Furnish one (1) year manufacturer warranty for valves.

1.9 EXTRA MATERIALS

- A. Furnish two (2) packing kits for each size valve.

PART 2 - PRODUCTS

2.1 HEATING AND COOLING VALVES

A. Globe Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
 - c. Milwaukee Valve
2. Two (2) inches and Smaller: Construction: Bronze body, bronze trim, union bonnet, rising stem and hand-wheel, inside screw, renewable plug disc and stainless-steel seat ring, solder or threaded ends.
3. Two (2) inches and Larger: Construction: Iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.

B. Ball Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
 - c. Belimo
 - d. Milwaukee Valve
2. Two (2) inches and Smaller: Bronze two-piece body, full port stainless steel ball and stem, Teflon seats and stuffing box ring, lever handle with balancing stops, solder or threaded ends with union.
3. Two (2) inches and Larger: Carbon steel body, stainless steel ball and stem, Teflon seat and stuffing box seals, lever handle, or gear drive hand-wheel for sizes ten (10) inches and larger, flanged.
4. Where piping is insulated, ball valves shall be equipped with two (2) inch extended handles of non-thermal conductive material. Also provide a protective sleeve to prevent damage to vapor seal when valve adjustment is made. Memory stops shall be adjustable after insulation is applied.

C. Plug Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
2. Two (2) inches and Smaller: Bronze body, bronze tapered plug, full port opening, non-lubricated, Teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench.
3. Two (2) inches and Larger: Cast iron body and plug, full port opening, pressure lubricated, Teflon packing, flanged ends. Furnish each plug valve with wrench with setscrew.

D. Butterfly Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
 - c. Dezurik
 - d. Haleson
 - e. Milwaukee Valve
2. Body: Cast or ductile iron with resilient replaceable EPDM seat, lug ends, extended neck.
3. Disc: Aluminum bronze.
4. Operator: 10 position lever handle on sizes two and half (2 1/2) inches to four (4) inches.
5. Hand-wheel and gear drive on sizes larger than six (6) inches.

E. Swing Check Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
 - c. Dezurik
 - d. Haleson
 - e. Milwaukee Valve
2. Two (2) and Smaller: Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder, or threaded ends.
3. Two and a half (2-1/2) inches and Larger: Iron body, bronze trim, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged ends or Ductile iron body, 316 stainless steel clapper, synthetic rubber bumper/seal and bonnet.

F. Spring Loaded Check Valves:

1. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Nibco
 - b. Crane
 - c. Dezurik
 - d. Haleson
 - e. Milwaukee Valve
2. Construction: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.
3. Two (2) and Smaller: Red bronze body, 301 stainless steel spring-actuated disc, EPDM o-ring, 300 series stainless steel stem and spring, in-line, lift-type check valve.

2.2 FLANGES AND UNIONS

- A. Unions for Pipe two (2) inches and Smaller:
 1. Ferrous Piping: 150 psig malleable iron, threaded.
 2. Copper Pipe: Bronze soldered or push-to-connect joints.
- B. Flanges for Pipe two (2) inches and Larger:
 1. Ferrous Piping: 150 psig forged steel, slip-on.
 2. Copper Piping: Bronze.
- C. Gaskets: 1/16-inch-thick preformed neoprene.
- D. Accessories: Stainless Steel bolts, nuts, and washers.
- E. Dielectric Connections:
 1. Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 2. Waterway fitting with zinc electroplated steel or ductile iron body, threaded or plain end, water impervious isolation barrier.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide non-conducting dielectric connections wherever joining dissimilar metals.
- B. Install valves with stems upright or horizontal, not inverted.
- C. Install unions downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment, or other apparatus.
- D. Install butterfly or ball shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

- E. Install calibrated-orifice, balancing valves at each branch connection to return main.
- F. Install globe or ball valves for throttling, bypass, or manual flow control services.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide flow controls in water re-circulating systems.
- I. Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.
- J. Use 1 1/4" inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- K. Install valves in accessible locations to permit removal of bonnet.
- L. Install valve stems in vertical position. Valve stems installed in horizontal position shall be no less than 30 degrees from horizontal.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe hangers and supports.
 - 2. Hanger rods.
 - 3. Inserts.
 - 4. Flashing.
 - 5. Equipment roof curbs and support rails.
 - 6. Sleeves.
 - 7. Mechanical link seals.
 - 8. Formed steel channel and angle.
 - 9. Equipment bases and supports.
 - 10. Portable roof pipe supports.
- B. Related Sections:
 - 1. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 2. Division 7 - Thermal and Moisture Protection.

1.3 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Manufacturer's Installation Instructions:
 - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Protect from weather, construction traffic, dirt, water, chemical, and mechanical damage.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Do not apply Firestopping materials when temperature of substrate material and ambient air is below 60 degrees Fahrenheit.
- B. Maintain this minimum temperature before, during, and for minimum 3 days after installation of Firestopping materials.
- C. Provide ventilation in areas to receive solvent cured materials.

1.8 WARRANTY

- A. Furnish one (1) year manufacturer warranty for pipe hangers and supports.

PART 2 - PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Carpenter & Paterson Inc.
 - 2. Flex-Weld, Inc.
 - 3. Globe Pipe Hanger Products Inc.
 - 4. Michigan Hanger Co.
 - 5. B-Line Systems
 - 6. Carpenter & Patterson Inc.
 - 7. Anvil International
 - 8. Piping Technology & Products
 - 9. Grinnell
- B. Hydronic Piping:
 - 1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.

2. Hangers for Cold Pipe Sizes two (2) inches and larger: Carbon steel, adjustable, clevis.
 3. Hangers for Hot Pipe Sizes 2 inches to 4 inches: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes six (6) inches and larger: Adjustable steel yoke, cast iron roll, double hanger.
 5. Multiple or Trapeze Hangers: Galvanized Steel channels with welded spacers and hanger rods.
 6. Multiple or Trapeze Hangers for Hot Pipe Sizes six (6) inches and larger: Galvanized Steel channels with welded spacers and hanger rods, cast iron rollers.
 7. Wall Support for Pipe Sizes three (3) inches and smaller: Cast iron hooks.
 8. Wall Support for Pipe Sizes four (4) inches and larger: Welded galvanized steel bracket and wrought steel clamp.
 9. Wall Support for Hot Pipe Sizes six (6) inches and larger: Welded galvanized steel bracket and wrought steel clamp with adjustable steel yoke and cast-iron roll.
 10. Vertical Support: galvanized Steel riser clamp.
 11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 12. Floor Support for Hot Pipe Sizes four (4) Inches and smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 13. Floor Support for Hot Pipe Sizes six (6) inches and larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 14. Copper Pipe Support: Copper-plated, carbon steel ring.
 15. Hydronic Piping shall not have support brackets welded to hydronic piping.
- C. Roof Mounted Hydronic Piping:
1. Refer to Division 7 –for hanger requirements and approved manufacturers.

2.2 HANGER RODS

- A. Hanger Rods: Hot dipped galvanized, mild steel threaded both ends, threaded on one end, or continuous threaded.

2.3 INSERTS

- A. Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

- A. In accordance with Division 7 - Thermal and Moisture Protection.

2.5 HOODED CURB

- A. Vent Hoods, Sleeves, Penetration Flashings, and Accessories: Minimum 24-gauge stainless steel.

2.6 EQUIPMENT ROOF CURBS AND SUPPORT RAILS

- A. Equipment roof curbs and support rails must be coordinated with roof type specified under Division 7.
- B. Roof mounted exhaust fans, intake hoods, relief hoods and supply fans shall be set on equipment manufacturers 12" high fabricated welded 18-gauge galvanized steel shell and base, mitered three (3) inch cant if required by roofing type, variable step to match roof insulation, 1-1/2-inch-thick curb insulation, factory installed treated wood nailer. Curb shall set level on roof without the need for blocking.
- C. Roof mounted unitary air conditioning units shall be set on a structural type of curb or equipment support rail. Curb or support rail shall be compatible with required vibration isolation specified under Section 23 05 48. Curb or support rail shall be 12" high welded 18-gauge galvanized steel shell and base, mitered three (3) inch cant if required by roofing type, variable step to match roof insulation, 1-1/2-inch-thick insulation, 3 lb. density, factory installed wood nailer and stainless-steel cap. Curb shall set level on roof without the need for blocking. Field bolted curbs are not acceptable.
- D. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. The Pate Co.
 - b. Custom Curb, Inc.
 - c. Roof Products, Inc.
- E. Refer to Division 7 - Thermal and Moisture Protection for additional requirements.

2.7 SLEEVES

- A. Sleeves for Pipes through fire rated or non-fire rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes through Rated or Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Sealant: Refer to Section 07 92 00 - Building Sealants.

2.8 MECHANICAL LINK SEALS

- A. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Thunderline Link-Seal / GPT.
 - 2. Innerlynx.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.9 FORMED STEEL CHANNEL AND ANGLE

- A. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Midland Ross Corporation, Electrical Products Division
 - 4. Unistrut Corp.
- B. Product Description: Galvanized 14 gage thick steel angle and galvanized 12 gage thick steel channel with holes 1-1/2 inches on center. Metal framing system for equipment support.
- C. All channel members and angles shall be hot-dipped galvanized and fabricated from structural grade steel and conform to applicable ASTM specifications.
- D. Structural members to be loaded within manufacturers design limitations and published data.

2.10 EQUIPMENT BASES AND SUPPORTS

- A. In accordance with Division 3 – Concrete
- B. Provide concrete equipment pads, reinforced with 6-inch x 6-inch welded wire mesh, chamfered edges and to be six (6) inches larger than base of equipment. Pad heights as follows:
 - 1. Hot Water Boilers: four (4) inches.
 - 2. Floor Mounted Pumps: four (4) inches.
 - 3. Floor Mounted Water Volume Tanks: four (4) inches.
 - 4. Air Handling Units: six (6) inches.
 - 5. Water Heaters: four (4) inches.
 - 6. Water Softeners: four (4) inches.
 - 7. Air Compressor: four (4) inches.
 - 8. Floor Mounted Expansion Tanks: four (4) inches.
 - 9. Floor Mounted chemical feeder tanks: four (4) inches.
 - 10. Floor Mounted Fans: four (4) inches.
 - 11. Chillers: four (4) inches.
 - 12. Condensing Units: four (4) inches.
 - 13. Heat Pump Units: six (6) inches.
 - 14. Dust Collectors: four (4) inches.
 - 15. Plasma cutters: four (4) inches.

- C. Provide vibration isolation in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.11 PORTABLE ROOF PIPE SUPPORTS

- A. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
1. Advanced Support Products (ASP)
 2. PHP System Design
- B. Steel and PVC Piping: Provide rooftop portable pipe supports in 8'-0" maximum intervals for steel, 4'-0" maximum intervals for PVC piping. Roof supports shall be provided with height adjustable crossbar and clevis hangers. Product specifications:
1. Support Base: 17" circular base, injected molded polypropylene, with 227 sq. in. of surface on bottom, designed for weight displacement.
 2. Base Dimensions: 3"H x 17" in diameter, designed for weight displacement, with molded insert for square tubing and two threaded rod couplings molded in.
 3. Height: Adjustable.
 4. Frame: 1-5/8" x 1-5/8" 12-gauge channel (ASTM A653), hot- dipped galvanized.
 5. Hardware: Corner brackets and leg brackets bolted with 1/2" x 2-1/2" bolt & 1/2" nut; frame bolted to support base with 1/2" x 2-1/2" bolts, 1/2" nuts and washers. Leg brackets and all thread rods, nuts and washers shall be hot- dipped galvanized.
 6. Required accessories: 1/2" threaded rod, clevis hangers, strut clamps and protection pads.
- C. Condensate disposal piping: Provide rooftop portable pipe supports in 8'-0" maximum intervals for steel condensate piping. Roof supports shall be manufactured by Advanced Support Products (ASP), model REC-SA (Rubber EcoCurb) with channel. Product specifications:
1. Bases: 100% recycled Vulcanized Rubber with UV inhibitors.
 2. Frame: 1-5/8" x 1-5/8" 12-gauge channel (ASTM A653), hot- dipped galvanized.
 3. Hardware: 1/2" threaded rods (12" high); 1/2" nuts & washers, hot- dipped galvanized.
 4. Height: Adjustable.
 5. Required accessories: Strut clamps and protection pads.
 6. Hot dipped galvanized threaded rods, nuts, and washers.
- D. Protection pads: Provide protection pad sheets between the roof / grade and support system. Protection pads shall not be adhered to either the roof or the support system.

1. Material: Porous rubber.
2. Weight: 2 lbs.
3. Dimensions: 18" square X ½" thick.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive Firestopping/Firesafing.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of Firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Do not drill or cut structural members.
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

3.3 STRUCTURAL STEEL

- A. All structural steel used to fabricate supports shall conform to ASTM A36.

3.4 CUTTING AND PATCHING

- A. In accordance with Division 7 - Thermal and Moisture Protection

3.5 FIRESTOPPING

- A. In accordance with Division 7 - Thermal and Moisture Protection.

3.6 FIRESTOPPING ACCESSORIES

- A. In accordance with Division 7 - Thermal and Moisture Protection.

3.7 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe four (4) inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.8 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2-inch minimum vertical adjustment.
- F. Support vertical piping at every other floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports.
- L. Provide clearance in hangers and from structure and other equipment for installation of pipe insulation. Refer to Section 23 07 19 - HVAC Piping Insulation.

3.9 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum four (4) inches thick and extending six (6) inches beyond supported equipment.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.10 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal Counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Provide curbs for mechanical roof installations 12 inches minimum above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach

Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

- C. Adjust storm collars tight to pipe with bolts, caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.
- D. Refer to Division 7 - Thermal and Moisture Protection for additional requirements.

3.11 INSTALLATION - SLEEVES

- A. Provide sleeves at all piping and ductwork penetrations of interior walls and slabs. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors two (2) inches above finished floor level. Caulk sleeves.
- E. Extend sleeves through walls two (2) inches each side.
- F. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with Firestopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install stainless steel escutcheons at finished surfaces.

3.12 INSTALLATION - FIRESTOPPING

- A. Install material at all fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items.
- B. Apply primer where recommended by manufacturer for type of Firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply Firestopping material in sufficient thickness to achieve required fire and smoke rating.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.
- E. Fire Rated Surface:
 - 1. Seal opening at floor, wall, and partition as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Pack void with backing material.

- d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
- F. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated wall and partition floor as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - 2. Install escutcheons, floor plates or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
 - 4. Interior partitions: Seal pipe penetrations. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

3.13 INSTALLATION - ACCESS DOORS

- A. Access Doors: Provide access doors as required for access to equipment, valves, controls, cleanouts, and other apparatus where concealed. Access doors shall have concealed hinges and screwdriver cam locks. Minimum size to be 12 inches x 12 inches in walls only for hand access and 24 inches x 24 inches minimum for all ceilings for maintenance access.
- B. All access doors located in wet areas such as restrooms, locker rooms, shower rooms, kitchen and any other wet areas shall be constructed of stainless steel.
- C. Access Doors:
 - 1. Plastic Surfaces: Milcor Style K.
 - 2. Ceramic Tile Surface: Milcor Style M.
 - 3. Drywall Surfaces: Milcor Style DW.
 - 4. Install panels only in locations approved by the Architect and with trim styles and color coordinated with surface to be installed in.

3.14 INSTALLATION – EQUIPMENT REQUIRING ROOF PORTAL BASES

- A. Verify that roof surface is smooth and clean to extent needed to receive material.
- B. Clean surfaces to receive 17" circular bases removing any loose gravel and foreign matter before setting 17" circular bases.
- C. Provide protective pad conforming to the new or existing roof manufacturer's system under each 17" circular bases. Do not adhere to the roof system or to circular bases.

3.15 FIELD QUALITY CONTROL

- A. Inspect installed Firestopping for compliance with specifications and submitted schedule.

3.16 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.17 PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

3.18 PIPE HANGERS

- A. Minimum hanger rod size shall be ½".
- B. Maximum hanger rod spacing shall not exceed 10'-0" on center for pipe sizes 2" and above. Do not exceed 7'-0" hanger spacing for pipes sizes less than 2" diameter.
- C. For trapeze supports provide a minimum of (2) two ½" hanger rods at each end of trapeze for a total of (4) four for pipes 10" or larger.
- D. Beam clamps are not acceptable.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Vibration isolation for building mechanical systems.
- B. Related Sections:
 - 1. Section - 23 05 16 - Expansion Fittings and Loops For HVAC Piping
 - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- C. Mason Industries model numbers are listed for identification only.
- D. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Mason Industries
 - 2. Kinetics Noise Control
 - 3. Amber / Booth
 - 4. VMC
 - 5. Vibration Eliminator
 - 6. Vibro-Acoustics

1.3 PERFORMANCE REQUIREMENTS

- A. It is the intent of this specification to provide vibration isolation supports for all equipment, piping and ductwork as may be required to prevent transmission of vibration to the building structure. It will be the Contractor's responsibility to select and install vibration isolators which will enable the noise criteria standards to be met, to the extent that the noise can be controlled by the vibration isolators.
- B. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or supplier.
- C. Unless otherwise noted or scheduled, spring type vibration isolators shall be used for all equipment driven by motors of 0.5 HP and larger. Deflections as tabulated are minimums and it shall be the responsibility of the isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance in order to prevent the transmission of objectionable vibrations and meet the noise criteria referenced herein.
- D. Unless otherwise noted, equipment driven by motors 0.25 HP and smaller shall be isolated by means of Type ND elastomeric mounts or Type HD elastomeric hangers properly sized for 0.35-inch deflection.
- E. All elastomeric isolators shall be of high-quality synthetic rubber with anti-ozone and anti-oxidant additives.

- F. Design and treat vibration isolators for resistance to corrosion. Furnish phosphatized steel components with epoxy powder paint coating. Components exposed to the weather shall be epoxy powder paint coated or hot-dipped galvanized. Furnish zinc electroplated nuts, bolts, and washers. Structural steel bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer.
- G. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind loads of 30 lbs/sq.ft. Wind loading shall be applied to all exposed surface of the isolated equipment in order to identify worst case load.
- H. Air handling equipment subjected to excessive horizontal air thrust operating at three (3) inches S.P. shall be furnished with Type WBI/WBD isolated thrust resisters to limit displacement to 1/4 inch.
- I. Height savings brackets used with isolators having 2.5-inch deflection or greater shall be of the precompression type to limit exposed bolt length.
- J. All spring isolators shall be completely stable in operation and shall be designed for not less than 50 percent reserve deflection beyond actual operating conditions. All spring isolators must be completely stable in operation and have a Kx/Ky ratio of at least 1:1.
- K. All isolation materials and flexible connectors shall be of the same manufacturer and shall be selected and certified using published or factory certified data. Any variance or non-compliance with these specification requirements shall be corrected by the contractor at no additional cost to the Owner. Manufacturer may purchase other manufactured products in order to meet this specification and shall guarantee outsourced product as a single point of responsibility. Outsourced products must be identified as such in the submittal for approval.
- L. The contractor and manufacturer of the isolation and equipment shall refer to the isolator schedule which lists isolator types and isolator deflections.
- M. Deflection table is based on maintaining rooms at the following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE and ANSI S1.8.
 - 1. Offices
Executive: 30
Conference rooms: 30
Private: 35
Open-plan areas: 35
Computer/business machine areas: 40
Public circulation: 40
 - 2. Schools
Lecture and classrooms: 30
Open-plan classrooms: 35
 - 3. Libraries: 25
 - 4. Theaters
Theater: 25
Stage house: 25
Trap room: 25
Orchestra pit: 25

Rehearsal rooms: 25
Teaching studios: 30
Practice rooms: 30
Ensemble rooms: 30
Shop: 45

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate assembly, materials, thickness, dimensional data, and layout as well as connection details.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating materials and dimensional data. All steel bases and concrete inertia bases shall be completely detailed. Include clearly outlined procedures for installing and adjusting the isolators.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded.
- E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- G. Manufacturer's Field Reports: Indicate vibration isolation installation is complete and in accordance with instructions. Provide a copy of field report to Architect/Engineer.

1.5 QUALITY ASSURANCE

- A. The vibration isolation manufacturer, or qualified representative, shall be responsible for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Vibration isolation manufacturer shall also inspect vibration isolation in units with factory provided isolation in order to confirm scheduled deflection and isolator type is in accordance with this specification. Upon completion of the installation and after the system is put into operation, the manufacturer, or representative, shall make a final inspection and submit his report to the Architect and Engineer in writing certifying the correctness of installation and compliance is in accordance approved submittal data.

1.6 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATOR TYPES

All vibration isolators described in this section shall be the product of a single manufacturer. Submittals and certification sheets shall be in accordance with Specification 1.3 of this section.

- A. Type WSW: Two layers of 3/8-inch thick neoprene pad consisting of square waffle modules separated horizontally by a 16-gauge galvanized shim. Where the load bearing area of the equipment is not the same size/shape as the load bearing area/shape of the pad, load distribution plates, minimum 1/4" thick galvanized steel, shall be utilized to ensure the load bearing capacity of the pad is maximized. Pads shall be sized for approximate deflection of 0.12 inch to 0.16 inch.
- B. Type ND: Neoprene mountings shall have minimum static deflection of 0.35 inch. All metal surfaces shall be neoprene covered and have friction pads both top and bottom. Bolt holes on the bottom and a tapped hole with a mounting bolt and washer shall be provided. Steel rails shall be used above the mountings under equipment such as small vent sets to compensate for the overhang. Where the load bearing area of the equipment or support structure is not the same size/shape as the load bearing area/shape of the pad, load distribution plates, minimum 1/4" thick galvanized steel, shall be utilized to ensure the load bearing capacity of the pad is maximized.
- C. Type SLF: Spring isolators shall be free-standing and laterally stable without any housing and complete with a steel-washer-reinforced molded neoprene cup of 1/4-inch neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have minimum additional travel to solid equal to 50 percent of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
- D. Type SLR: Restrained spring mountings shall have an SLF mounting as described in Specification 2.1 C, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2 inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position under outdoor equipment, there must be an internal isolation pad in addition to the friction pad on bottom.
- E. Type HD: Hangers shall consist of rigid steel frames containing minimum 1-1/4-inch-thick neoprene element. The neoprene element shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers.
- F. Type 30N: Hangers shall consist of rigid steel frames containing minimum 1-1/4-inch-thick neoprene elements at the top and a steel spring as described in 2.1 C, seated in a steel-washer-reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers, nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30-degree arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30-degree capability.
- G. Type PC30N: Hangers shall be as described in Specification 2.1 F, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after installation is complete.

and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30-degree capability.

- H. Type WBI/WBD: Horizontal thrust restraints shall consist of a spring element in series with a neoprene molded cup, as described in paragraph 2.1 C, with the same deflection as specified for the mountings or hangers supporting the unit. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4-inch movement at start and stop. The assembly shall be furnished with a rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit.
- I. Type SLR-MT: Restrained air spring mountings shall be manufactured with upper and lower steel sections connected by a replaceable flexible DuPont Kevlar reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. Restrained air springs shall be within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2 inch {12mm} shall be maintained around restraining bolts and between the housing and the air springs so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Air spring systems shall be connected to a supplementary air supply compressor (supplied with the air spring system) through a Mason Industries air spring control panel and equipped with three leveling valves to maintain level within plus or minus 0.125". Air spring mounts are to be located between the supporting steel and the roof or the grillage and dunnage as shown on the drawings when there is no provision for direct mounting. Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.

2.2 BASES

- A. Type WF: A welded integral structural steel fan and motor base with NEMA standard motor slide rails and holes drilled to receive the fan and motor slide rails. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split-case pumps shall be large enough to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14 inches provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height-saving brackets shall be employed in all mounting locations to maintain a 1-inch operating clearance under base.
- B. Type ICS: Vibration isolation manufacturer shall provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base. Members shall have sufficient rigidity to prevent misalignment of equipment.
- C. Type RBMK. Vibration isolation manufacturer shall furnish structural steel concrete pouring forms for floating concrete bases. Wood formed bases, formed steel bases and sheet metal formed bases are not acceptable. Bases for split-case pumps shall be large enough to provide for suction and discharge elbows. Bases may be T or L shaped where

space is a problem. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6 inches. The base depth need not exceed 12 inches unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2-inch bars welded in place on 6-inch centers running both ways in a layer 1-1/2 inches above the bottom. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Recessed height-saving brackets shall be employed in all mounting locations to maintain a 1-inch operating clearance under base.

2.3 FLEXIBLE PIPE CONNECTIONS (CHILLERS AND BASE-MOUNTED PUMPS)

- A. Type SFDEJ, SFEJ, SFDCR or SFU with Control Rods CR (required): Flanged and threaded rubber flexible joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14" shall have a ductile iron external ring between the two spheres. Sizes 16" through 24" may be single sphere. Sizes 3/4" through 2" may have one sphere, bolted threaded flange assemblies and cable retention. Minimum ratings through 14" shall be 250psi at 170°F and 215psi at 250°F, 16" through 24" 180psi at 170°F and 150psi at 250°F. Higher published rated connectors may be used where required. Safety factors shall be a minimum of 3/1. All flexible joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment. The piping gap shall be equal to the length of the flexible joint under pressure. Control rods passing through 1/2" thick Neoprene washer bushings large enough to take the thrust at 1000psi of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the flexible joint rating without them. Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- B. Isolators shall be installed as recommended by the manufacturer. Isolate all mechanical equipment 0.5 hp and over per the isolation schedule and these specifications.

3.2 PIPING ISOLATION

- A. Horizontal Pipe Isolation: All pumped water, pumped condensate, and refrigerant piping size 1-1/4 inch and larger within mechanical rooms and on pipe size 2 inch and larger outside mechanical rooms shall be isolated. Outside equipment rooms this piping shall be isolated for the greater of 50 feet or 100 pipe diameters from externally isolated equipment. For the first 3 support locations from externally isolated equipment provide Type 30N hangers or Type SLF floor mounts with the same deflection as equipment isolators. All other piping within the equipment rooms shall be isolated with the same specification isolators with a 1" inch minimum deflection. Install piping hangers at regular intervals according to the pipe hanger schedule. Where floor supports are required, provide sufficient spring capacity to absorb expansion and contraction of piping, and yet to permit piping to function as a floating system. Size hangers for 200 percent rated load. Coordinate selection of piping supports with equipment supports to accommodate expansion and contraction without creating excessive stresses at equipment connections.
- B. Pipe Riser Isolation: All vertical pipe risers 1-1/4 inch and larger, where specifically shown and detailed on riser drawings shall be fully supported by Type SW SLF isolators with brackets. Refer to details on Drawings. Steel spring deflection shall be 3/4 inch

minimum. In locations where added deflection is required due to pipe expansion/contraction, the spring deflection shall be a minimum of 4 times the anticipated deflection change. Springs shall be selected to keep the riser in tension. Wall sleeves for take-offs from riser shall be sized for insulation O.D. plus two times the anticipated movement to prevent binding. Provide Type SWS wall sleeves. In addition to submittal data requirements previously outlined, riser diagrams and calculations shall be submitted for approval. Calculations must show anticipated expansion and contraction at each support point, initial and final loads on the building structure, and spring deflection changes. Submittal data shall include certification that the piping system has been examined for excessive stresses and that none will exist in the design proposed.

3.3 INSTALLATION

- A. Comply with manufacturer's instructions for the installation and load application of vibration isolation materials and products. Adjust to ensure that units do not exceed rated operating deflections or bottom out under loading and are not short-circuited by other contacts or bearing points. Remove space blocks and similar devices (if any) intended for temporary protection against overloading during installation or shipment.
- B. Locate isolation hangers as near the overhead support structure as possible.
- C. Adjust leveling devices as required to distribute loading uniformly on isolators. Shim units as required where leveling devices cannot be used to distribute loading properly.
- D. Install isolated inertia base frames and steel bases on isolator units as indicated so that a minimum of one (1) inch clearance below base will result when supported equipment has been installed and loaded for operation.
- E. Install Work in accordance with ASME B31.9.
- F. Install flexible pipe connectors to equipment supported by vibration isolation. Provide line size flexible connectors.
- G. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.
- H. Refer to Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- I. Contractor shall install load distribution plates provided by vibration isolation manufacturer on WSW type isolators. Plates shall be aligned with isolation pad.

EQUIPMENT ISOLATION SCHEDULE						
EQUIPMENT	LOCATION					
	ELEVATED STRUCTURE			SLAB ON GRADE		
	ISOLAT OR TYPE	MINIMUM DEFLECT ION (Inches)	BASE (1) TYPE	ISOLAT OR TYPE	MINIMUM DEFLECT ION (Inches)	BASE (1) TYPE

AIR HANDLING UNITS (NOTE 2)						
FLOOR MOUNTED	SLF	0.75	-	SLF	0.75	-
TO 15 HP	SLF	1.5	-	SLF	0.75	-
20 HP & OVER	30N	1	-	30N	1	-
SUSPENDED	PC30N	1.75	-	PC30N	1	-
UP TO 15 HP						
20 HP & OVER	SLF/W	1.5	RBMK	SLF/W	0.75	RBMK
HIGH PRESSURE FAN	BI	2.5	RBMK	BI	1.5	RBMK
SECTION (NOTE 1)	SLF/W			SLF/W		
UP TO 30 HP	BI			BI		
40 HP & OVER						
CENTRIFUGAL FANS						
CL. I & II UP TO 54-1/2" W.D.						
Up to 15 HP	SLF	0.75	WF	SLF	0.75	WF
20-50 HP	SLF	1.5	RBMK	SLF	0.75	WF
60 HP & OVER	SLF	2.5	RBMK	SLF	1.5	WF
CL. I & II 60" W.D. & OVER/ALL						
CL. III FANS UP TO 15 HP	SLF/W	1.5	RBMK	SLF/W	0.75	RBMK
20-50 HP	BI	2.5	RBMK	BI	1.5	RBMK
60 HP & OVER	SLF/W	2.5	RBMK	SLF/W	1.5	RBMK
	BI			BI		
	SLF/W			SLF/W		
	BI			BI		
AXIAL-FLOW FANS (NOTE 1)						
FLOOR MTD.						
UP TO 15 HP	SLF	0.75	-	SLF	0.75	-
20 HP & OVER	SLF	1.5	-	SLF	0.75	-
SUSPENDED (NOTE 1)						
UP TO 15 HP	30N	1	-	30N	1	-
20 HP & OVER	PC30N	1.75	WF	PC30N	1.5	-
VENT (UTILITY SETS)						
FLOOR MTD.	SLF	0.75	-	SLF	0.75	-
SUSPENDED	30N	1	-	30N	0.75	-
CABINET FANS, FAN						
SECTIONS (NOTE 1)						
CL. I & II UP TO 54-1/2" W.D.	SLF	0.75	-	SLF	0.75	-
Up to 15 HP	SLF	1.5	-	SLF	0.75	-
20-50 HP						
SUSPENDED	30N	1	-	30N	0.75	-
UP TO 15 HP	PC30N	1.75	-	30N	1.75	-
20 HP & OVER						
PUMPS						
FLOOR MTD. UP TO 60 HP	SLF	1.50	RBMK	SLF	0.75	RBMK
FLOOR MTD. 75 HP AND	SLF	2.50	RBMK	SLF	0.75	RBMK
LARGER						
SUSPENDED INLINE	PC30N	1.75	-	PC30N	1.75	-
REFRIGERATION UNITS						
RECIPROCATING	SLF	1.5	RBMK	SLF	0.75	RBMK
COMPRESSORS	SLR/IC	1.5	-	SLF	0.75	-
RECIPROCATING COND.	S	1.5	-	WSW	0.15	-
UNITS & CHILLERS	SLR	1.5	RBMK	WSW	0.15	-

HERMETIC CENTRIFUGALS OPEN CENTRIFUGALS ABSORPTION MACHINES	SLF SLR/IC S	0.75	-	WSW	0.15	-
AIR COMPRESSORS TANK TYPE (HORIZONTAL TANK)	SLF	1.5	-	SLF	0.75	-
TANK TYPE (VERTICAL TANK)	SLF	1.5	-	SLF	0.75	-
COOLING TOWERS & CLOSED-CIRCUIT COOLERS UP TO 500 TONS	SLR	0.75	(1)	WSW	0.15	-
OVER 500 TONS	SLR	2.5	(1)	WSW	0.15	-
AIR COOLED CONDENSERS UP TO 50 TONS	SLR	0.75	(1)	WSW	0.15	-
OVER 50 TONS	SLR	1.5	(1)	WSW	0.15	-
ROOFTOP AIR CONDITIONING UNITS REQUIRING WEATHER SEAL	SLF	0.75	RSC/C	-	-	-
UP TO 5000 CFM (12 TON)	SLR	1.5	MAB	-	-	-
OVER 5000 CFM (12 TON)	SLR	1.5	RSC/C	-	-	-
OTHER TYPES	SLR	1.5	MAB	-	-	-
UP TO 25 TONS			(1)			
OVER 25 TONS			(1)			
BOILER (PACKAGE TYPE) ALL SIZES	SLR	0.75		WSW	0.15	-
ENGINE DRIVEN GENERATORS UP TO 60 HP	SLR	1.5	RBMK	SLR	0.75	-
75 HP & OVER	SLR	2.5	RBMK	SLR	0.75	-

Notes:

1. Provide steel base type WF if equipment requires base frame or does not include integral base rail for vibration isolation.
2. Provide WSW isolator type with load distribution plate for floor mounted AHU's that are internally isolated. Isolation deflection and type specified refers to factory isolation requirements.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Tags.
 - 3. Stencils.
 - 4. Pipe markers.
 - 5. Ceiling tacks.
 - 6. Labels.
 - 7. Lockout devices.
 - 8. Pipe painting (if required)
- B. Related Sections:
 - 1. Section 09 91 00 - Painting and Staining.
- C. Color scheme for identification must be coordinated with district standards. Color scheme specified is bases of design if required for project. Contractor shall confirm painting requirements with Architect/District.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.
 - 2. District Standards for identification and color scheme.

1.4 SUBMITTALS

- A. Product Data: Submit manufacturers catalog literature for each product required.
- B. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Identify painting requirements as directed by Architect/District. Contractor to confirm if painting of piping is required for project. Contractor shall provide primer coat on un-insulated outdoor condenser water piping as a minimum.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.6 QUALITY ASSURANCE

- A. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
- B. Conform to ANSI / OSHA Pipe Marking Specifications.
- C. Specification is not limited to manufacturers listed. Substitutions are allowed in accordance with Division 1 - General Requirements and Division 23, Section 23 05 00 - Common Work Results for HVAC.

1.7 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Craftmark Identification Systems.
 - 2. Safety Sign Co.
 - 3. Seton Identification Products.
 - 4. Almetek Industries.
 - 5. Marking Services, INC. (MSI).
 - 6. Brimar.
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Plastic Tags:
 - 1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
 - 2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches.

B. Metal Tags:

1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.

C. Information Tags:

1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.

- D. Tag Chart: Typewritten letter size list of applied tags and location in plastic laminated chart to indicate valve make, size, model, and service.

2.3 STENCILS

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:

1. Craftmark Identification Systems.
2. Safety Sign Co.
3. Seton Identification Products.
4. Almetek Industries.
5. Marking Services, INC. (MSI).
6. Brimar.

- B. Stencils: With clean cut symbols and letters of following size:

1. Up to two (2) inches Outside Diameter of Insulation or Pipe: 1/2-inch-high letters.
2. 2-1/2 to six (6) inches Outside Diameter of Insulation or Pipe: one (1) inch high letters.
3. Over six (6) inches Outside Diameter of Insulation or Pipe: 1-3/4 inches high letters.
4. Ductwork and Equipment: 1-3/4 inches high letters.

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- C. Stencil Paint: As specified in Section 09 91 00 Paintings and Staining, semi-gloss enamel, colors, and lettering size in conformance with ASME A13.1.

2.4 PIPE MARKERS

A. Plastic Pipe Markers:

- 1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
- 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.

B. Plastic Tape Pipe Markers:

- 1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
- 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

C. Plastic Underground Pipe Markers:

- 1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
- 2. Bright colored continuously printed plastic ribbon tape, minimum six (6) inches wide by 4 mil thick, manufactured for direct burial service.

2.5 CEILING TACKS

A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:

- 1. Craftmark Identification Systems.

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2. Safety Sign Co.
3. Seton Identification Products.
4. Almetek Industries.
5. Marking Services, INC. (MSI).
6. Brimar.

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

2.6 LABELS

A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:

1. Craftmark Identification Systems.
2. Safety Sign Co.
3. Seton Identification Products.
4. Almetek Industries.
5. Marking Services, INC. (MSI).
6. Brimar.

B. Description: Laminated Mylar, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

2.7 LOCKOUT DEVICES

A. Lockout Hasps:

1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:

1. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - a. Craftmark Identification Systems.
 - b. Safety Sign Co.
 - c. Seton Identification Products.
 - d. Almetek Industries.
 - e. Marking Services, INC. (MSI).
 - f. Brimar.
2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 91 00 Paintings and Staining for stencil painting.

3.2 INSTALLATION

- A. Apply stencil painting in accordance with Section 09 91 00 Paintings and Staining.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- D. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain or 4 ply 0.018 smooth copper wire. Tags shall be numerically sequenced with all valves of each system type grouped together.
- F. Install underground plastic pipe markers six (6) to eight (8) inches below finished grade, directly above buried pipe.
- G. All exterior visible piping shall be identified with UV and acid resistant outdoor pipe markers.
- H. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify air terminal units and radiator valves with numbered tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify insulated piping, concealed, or exposed indoor with plastic tape pipe markers. Use tags on piping 3/4-inch diameter and smaller. Use plastic pipe UV protected markers on exterior piping. Identify service and flow direction. Install in clear view and align with axis of piping. Locate identification at every 20 feet on center for straight runs including risers and drops. Locate identification adjacent to each valve and tee, at each side of penetration of wall or enclosure, and at each obstruction.
- M. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment. Coordinate with Architect.
- N. Identify un-insulated piping with plastic pipe markers. Locate identification at every 20 feet on center for straight runs including risers and drops. Locate identification adjacent to each valve and tee, at each side of penetration of wall or enclosure, and at each obstruction.

3.3 IDENTIFICATION SCHEDULE

- A. Markers shall be colored as indicated below per ANSI/OSHA Standards OR as specified in District Standards:

SYSTEM	COLOR	LEGEND
Chilled Water	Green	Chilled Water Supply Chilled Water Return
Domestic Water	Green	Domestic Water
Domestic Hot Water Supply	Yellow	Domestic Hot Water Supply
Domestic Hot Water Return	Yellow	Domestic Hot Water Return
Fire Protection	Red	Fire Protection
Automatic Sprinkler	Red	Fire Sprinkler
Gas	Yellow	Natural Gas
Condenser Water	Green	Condenser Water Supply Condenser Water Return

B. **PIPE PAINTING:**

1. All piping exposed to view in conditioned spaces shall be painted as indicated or as directed by the Architect in the field. Confirm all color selections and painting requirements with Architect/District prior to installation.
2. The entire fire protection piping system shall be painted red.
3. All outdoor un-insulated piping shall be painted with primer as a minimum.
4. All piping located in mechanical rooms and outdoor piping shall be painted as indicated in Painting Schedule. Painting requirement must be confirmed by contractor.

C. PAINTING SCHEDULE

SYSTEM	COLOR
Storm Sewer	White
Sanitary Sewer Waste and Vent	Light Gray
Domestic Cold Water	Dark Blue
Domestic Hot Water Supply and Return	Orange
Condenser Water Supply and Return	Light Green
Gas	Yellow
Chilled Water Supply and Return	Light Blue
Heating Hot Water supply and Return	Reddish Orange

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Testing, adjusting, and balancing of air systems.
 - 2. Testing, adjusting, and balancing of Hydronic piping systems
 - 3. Testing, adjusting, and balancing of refrigerating systems.
 - 4. Measurement of final operating condition of HVAC systems.
 - 5. Sound measurement of equipment operating conditions.
 - 6. Vibration measurement of equipment operating conditions.
- B. Related Sections:
 - 1. Sequences of operation for HVAC equipment as scheduled on Drawings.
- C. Testing, Adjusting and Balancing (TAB) contractor shall bid work specified under this section direct to Owner. TAB contractor shall not be hired by general contractor or any sub-contractor.
- D. Mechanical contractor is responsible for coordinating work with the TAB Contractor. Mechanical contractor requirements are specified herein.
- E. TAB Contractors:
 - 1. Engineered Air Balance
 - 2. Precision Air

1.3 REFERENCES

- A. Associated Air Balance Council:
 - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- C. Natural Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- C. Engineer and Technicians Data: Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.
- D. Procedures and Agenda: Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed to be used for this project.
- E. Sample Forms: Submit sample forms, if other than those standard forms, if other than those standard forms prepared by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB) are proposed.
- F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:
 - 1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit two (2) complete sets of draft reports. Only one (1) complete set of draft reports will be returned.
 - 2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit two (2) complete sets of final reports.
 - 3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binder. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs.
 - a. General Information and Summary
 - b. Air Systems
 - c. Refrigerant Systems
 - d. Temperature Control Systems
 - e. Special Systems.
 - 4. Report Contents: Provide the following minimum information, forms and data:

- a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, the Company, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
- b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
- c. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six (6) months prior to starting the project.

1.5 QUALITY ASSURANCE

- A. Test and Balance Engineer's Qualifications: A Professional Engineers registered in the State in which the services are to be performed and having at least three (3) years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this project.
- B. Agency Qualifications:
 1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to the test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications and recording and reporting the results.
 2. The independent testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or by the Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one Professional Engineer registered in the State in which the services are to be performed, certified by NEBB or AABC as a Test and Balance Engineer.
- C. Codes and Standards
 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
 2. AABC: "National Standards for Total System Balance."
 3. American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) ASHRAE Handbook, 1999 HVAC Applications Volume, Chapter 36, Testing, Adjusting, and Balancing.

- D. Pre-Balancing Conference: Prior to beginning of testing, adjusting, and balancing procedures, schedule and conduct a conference with the Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of the system operation and readiness for testing, adjusting, and balancing.

1.6 PROJECT CONDITIONS

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.7 SEQUENCING AND SCHEDULING

- A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.
- B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within five (5) degrees Fahrenheit wet bulb temperature of maximum summer design condition, and within ten (10) degrees Fahrenheit dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
- C. Notice: Provide minimum 7 days advanced notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 SERVICES OF THE MECHANICAL CONTRACTOR

- A. Examine the contract documents to become familiar with Project requirements and to discover conditions in systems design that may preclude proper TAB of systems and equipment.
- B. Examine the approved submittals for HVAC systems and equipment.
- C. Verify systems are complete and operable before commencing work. Verify the following:
 - 1. Systems are started and operating in safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed, and duct end caps are in place.

10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place or in normal position.
 15. Service and balancing valves are open.
 16. Re-sheave
- D. Contractor shall provide all volume dampers, balancing dampers, balancing valves, test ports and Pete's plugs as required by the Testing and Balancing Firm. Contractor shall furnish a set of sheet metal shop drawings and HVAC piping drawings to the Testing and Balancing Firm during the submittal phase and incorporate the Testing and Balancing Firm's mark-ups and requests into the project. Contractor shall provide all required equipment to facilitate Testing and Balancing Firm's work. This coordination shall be included in the Contractor's base bid price.
- E. Provide, correct, repair or replace deficient items or conditions found during the testing and balancing.
- F. Provide replacement sheaves as directed by TAB Contractor to achieve scheduled air volumes.
- G. For motors with a variable frequency drive, contractor shall provide belt and sheave adjustment such that units deliver their design cfm when speed drive is at 60 hertz.

3.2 SERVICES OF THE TESTING AND BALANCING CONTRACTOR

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.
- C. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 INSTALLATION TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust fans and Equipment with Fans: +/- 5%
 2. Air Outlets and Inlets: +/- 5%
 3. Heating-Water Flow Rate: +/- 5%

4. Cooling-Water Flow Rate: +/- 5%

3.4 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross-sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- K. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries in clean rooms.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from construction manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - 3. Re-measure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR DUAL-DUCT SYSTEMS

- A. Verify that the cooling coil is capable of full-system airflow and set mixing boxes at full-cold airflow position for fan volume.
- B. Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
 - 1. If insufficient static pressure exists, increase airflow at the fan.
- C. Test and adjust the constant-volume mixing boxes as follows:
 - 1. Verify both hot and cold operations by adjusting the thermostat and observing changes in air temperature and volume.
 - 2. Verify sufficient inlet static pressure before making volume adjustments.
 - 3. Adjust mixing boxes to indicated airflows within specified tolerances. Measure airflow by Pitot-tube traverse readings or by measuring static pressure at mixing-box taps if provided by mixing-box manufacturer.
- D. Do not over pressurize ducts.

- E. Re-measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate controls of mixing boxes and to overcome resistance in the ducts and outlets downstream from mixing boxes.
- F. Adjust variable-air-volume, dual-duct systems in the same way as constant-volume, dual-duct systems; adjust maximum- and minimum-airflow setting of each mixing box.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Re-measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - b. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 - 8. Record final fan-performance data.

- C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Balance variable-air-volume systems the same as described for constant-volume air systems.
 2. Set terminal units and supply fan at full-airflow condition.
 3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 4. Readjust fan airflow for final maximum readings.
 5. Measure operating static pressure at the sensor that controls the supply fan if one is installed and verify operation of the static-pressure controller.
 6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
- D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.

7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.9 PROCEDURES FOR MULTIZONE SYSTEMS

- A. Set unit at maximum airflow through the cooling coil.
- B. Adjust each zone's balancing damper to achieve indicated airflow within the zone.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
 1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

- a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner/Engineer and comply with requirements in "Hydronic Pump Specification."
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated pre-settings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 1. Determine the balancing station with the highest percentage over indicated flow.
 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Balance systems with automatic two and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.14 PROCEDURES FOR DOMESTIC HOT WATER SYSTEMS

- A. The test and balance contractor shall provide testing, adjusting and balancing of the hot water system, once the system is fully installed and operational. Preliminary and final reports shall be prepared and issued to the General Contractor, Architect and Engineer.
- B. Preparation of the hot water system for balancing:
 - 1. Confirm outlet temperature of the system at water heaters and/or storage tanks.
 - 2. Verify recirculation pump operation and rotation.
 - 3. Confirm/adjust setpoint of each individual riser balancing valve to flow a minimum of 0.5 gpm or as otherwise noted on the documents.
- C. The test and balance report shall indicate the following:
 - 1. Pressure, temperature and flow in gpm at the discharge side of each balancing valve referencing the valve tag number.
 - 2. Pressure, temperature and flow in gpm at the suction side of each circulating pump.

3.15 PROCEDURES FOR HEAT EXCHANGERS

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures.
- D. Measure inlet steam pressure.
- E. Check settings and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.

5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.17 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 6. Capacity: Calculate in tons of cooling.
 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.18 PROCEDURES FOR COOLING TOWERS

- A. A complete Factory CTI certified test of the cooling tower will be performed at the expense of the cooling tower manufacturer. A copy of this test (provided by others) shall be included in the final TAB report. Balance the flow over and through bypass connections of the tower.

3.19 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.20 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.21 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.22 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 1. Pump curves.
 2. Fan curves.
 3. Manufacturers' test data.
 4. Field test reports prepared by system and equipment installers.
 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 1. Title page.
 2. Name and address of the TAB contractor.
 3. Project name.
 4. Project location.
 5. Architect's name and address.
 6. Engineer's name and address.
 7. Contractor's name and address.
 8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.

- e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Water and steam flow rates.
 - 3. Duct, outlet, and inlet sizes.
 - 4. Pipe and valve sizes and locations.
 - 5. Terminal units.
 - 6. Balancing stations.
 - 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).

- i. Outdoor airflow in cfm (L/s).
- j. Return airflow in cfm (L/s).
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

G. Gas Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h (kW).
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.

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- b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Suction static pressure in inches wg (Pa).
- J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg (Pa).
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig (Pa).
- K. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.

- f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - 1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 - 2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm (L/s).
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Service.
 - d. Make and size.
 - e. Model number and serial number.
 - f. Water flow rate in gpm.
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches.
 - k. Motor make and frame size.
 - l. Motor horsepower and rpm.
 - m. Voltage at each connection.
 - n. Amperage for each phase.
 - o. Full-load amperage and service factor.

p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

N. Vibration Test:

1. Location of points:

- a. Fan bearing, drive end
- b. Fan bearing, opposite end
- c. Motor bearing, center (when applicable)
- d. Motor bearing, drive end
- e. Motor bearing, opposite end
- f. Casing (bottom or top)
- g. Casing (side)
- h. Duct after flexible connection (discharge)
- i. Duct after flexible connection (suction)

2. Test readings:

- a. Horizontal, velocity and displacement
- b. Vertical, velocity and displacement
- c. Axial, velocity and displacement
- d. Normally acceptable readings, velocity and acceleration
- e. Unusual conditions at time of test
- f. Vibration source (when non-complying)

O. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

END OF SECTION 23 05 93

SECTION 23 07 13 - DUCT INSULATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- B. Section Includes: Insulation systems for sheet metal duct conveying cold, hot, and grease laden air.

1.3 SYSTEM DESCRIPTION

- A. Design Requirements: Provide duct insulation systems which have been manufactured, fabricated, and installed to meet all thermal requirements of mechanical systems. Insulating systems shall be installed in strict accordance with manufacturer's field requirements and the current International Energy Conservation Code including all local amendments and criteria specified herein.
- B. Performance Requirements: Provide duct insulation systems which have been manufactured and installed to meet the following standards:
- C.
 - 1. NFPA 90A.
 - 2. NFPA 90B.
 - 3. UL 723, ASTM E84: Flamespread 25, smoke developed 50.
 - 4. ASTM C1136: 150 degrees F.
 - 5. ASTM C1290.
 - 6. UL 181 for Class I Air Duct.
 - 7. NAIMA AHS-152T.

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by **highlighting** or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show specific pertinent performance data and quantities appropriate to scope of work
- C. Submit manufacturer's product data and installation instructions.
- D. Provide drawings indicating typical duct insulation details, thickness and location. Identify areas and required insulation.
- E. Manufacturer's certificate that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Utilize an installer having demonstrated five (5) years experience on projects of similar size and complexity.

- B. Condensation on any insulated system is not acceptable. Contractor shall replace insulation deemed unacceptable due to exposure to condensation at no additional cost to project.
- C. Insulation to provide minimum R-value in accordance with current International Energy Conservation Code including all local amendments and criteria specified herein.

1.6 DELIVERY, STORAGE & HANDLING

- A. Deliver insulation materials in manufacturer's original, unopened containers with identification labels intact.
- B. Contractor shall adequately protect insulation from damage after delivery to the project. Materials shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver materials to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – MUST BE MANUFACTURED AND BRANDED BY ONE OF THE FOLLOWING:

- A. Fiber Glass Insulation: Subject to compliance with plans and specification, provide one of the following:
 - 1. Owens Corning
 - 2. Johns Manville
 - 3. CertainTeed
 - 4. Knauf brand Insulation
- B. Mastics and Adhesive: Subject to compliance with plans and specification, provide one of the following:
 - 1. Childers
 - 2. Foster
 - 3. Vimasco
- C. Fiberglass Reinforcing Cloth Mesh: Subject to compliance with plans and specification, provide one of the following:
 - 1. Perma Glass
 - 2. Alpha Glass
 - 3. Childers
 - 4. Vimasco

- D. Fire Wrap Insulation: Subject to compliance with plans and specification, provide one of the following:
1. 3M Fire Barrier Duct Wrap
 2. Vesuvius Pyroscat Duct Wrap
 3. Unifrax Corporation

2.2 DUCT WRAP

- A. Material: Resilient blanket of fiberglass insulation factory laminated to foil/kraft vapor retarder facing.
- B. Density: 0.75 pounds per cubic foot.
- C. Installed minimum R value: 8.3.
- D. Nominal Thickness: 3.0 inches.
- E. Installed Thickness: 2-1/4 inches.
- F. Installed Thermal Conductivity (compressed): $k = 0.27$
- G. Operating Temperature (ASTM C411): up to 250° Fahrenheit.
- H. Insulation Jacket Temperature Limit (ASTM C1136): up to 150° Fahrenheit.
- I. Water Vapor Sorption (ASTM C1104): < 3 percent by weight at 120° Fahrenheit, 95% RH.
- J. Testing Method 1338: Fungi Resistance Comply with requirements.
- K. ASTM 665 Mineral Fiber Thermal Insulation: Comply with requirements.
- L. Surface Burning Characteristics (ASTM E84): Flame spread 25, smoke developed 50.

2.3 ACOUSTICAL FLEXIBLE DUCT LINER:

- A. Material: Acoustical insulation applied to interior of sheet metal ducts. Semi-rigid board of glass fibers with a tough, fire-resistant, anti-microbial, acrylic coating on the airstream side. Factory applied edge coating. Duct liner for rectangular and round duct as required.
- A. Density: 1.5 pounds per cubic foot.
- B. Installed minimum R value: 6.3.
- C. Thickness: 1-1/2 inches.
- D. Thermal Conductivity k , (ASTM C518): 0.24
- E. Acoustic Performance: Sound absorption coefficients at octave band center frequencies (Hz)
- | Freq. (Hz) | <u>125</u> | <u>250</u> | <u>500</u> | <u>1K</u> | <u>2K</u> | <u>4K</u> | <u>NRC</u> |
|------------|------------|------------|------------|-----------|-----------|-----------|------------|
| TL (dB) | 0.19 | 0.55 | 0.84 | 1.0 | 1.0 | .98 | .85 |
- F. Material Standards: Comply with NFPA 90A, NFPA 90B, and ASTM C1071.

- G. Operating Temperature (ASTM C411): 250 degrees Fahrenheit.
- H. Maximum Air Velocity (UL 181 Erosion test ASTM C1071): 6,000 fpm.
- I. Water Vapor Sorption (ASTM C1104): < 3 percent by weight at 120°F, 95% RH.
- J. Fungi Resistance (ASTM C1338 & G21): Comply with requirements.
- K. Bacteria Resistance (ASTM G22): Comply with requirements.
- L. Corrosiveness (ASTM C665): Will not cause corrosion greater than that caused by sterile cotton on aluminum or steel.
- M. Surface Burning Characteristics (ASTM E84, UL 723): Flame spread 25, smoke developed 50.

2.4 GREASE EXHAUST DUCT

- A. 1-1/2-inch-thick refractory ceramic blanket or calcia, magnesia and silica with aluminum foil, fiberglass-reinforced scrim encapsulation.
- B. Product to be UL Listed as a two (2) hour duct enclosure.
- C. Product shall be tested in accordance with the following:
 - 1. ASTM G 411
 - 2. ASTM C 51
 - 3. ASTM E 84
 - 4. ASTM E 119
 - 5. ASTM E 136
 - 6. ASTM E 814
 - 7. UL 1978 Sections 12 and B

2.5 ACCESSORIES

- A. Pressure-Sensitivity Aluminum Foil Tapes:
 - 1. Material Standard: Listed and labeled under UL 181A, Part I, identified by name, date of manufacture, product name/number and UL 181A.
 - 2. Size: At least 2-1/2 inches wide.
- B. Heat-Activated Tapes:
 - 1. Material Standard: Listed and labeled under UL 181A, Part II, identified by name, date of manufacture, product name/number and UL 181A, may be used in all applications except for bonding to sheet metal.
 - 2. Size: At least three (3) inches wide.
- C. Mastic and Glass Fabric System:
 - a. Material Standard: Listed and labeled under UL 181A, Part III.
 - b. Size: At least three (3) inches wide.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Comply with the instructions and recommendations of the duct insulation manufacturer.

3.2 INSTALLATION

A. ACOUSTICAL LINING OF SHEET METAL DUCT AND FITTINGS:

1. Completely cover all portions of duct designated to receive duct liner with duct liner material. Neatly butt all transverse joints with no interruptions or gaps. The black pigmented or mat faced surface of the duct liner shall face the airstream.
2. Affix duct liner to the sheet metal with 90 percent coverage of adhesive complying with the requirements of ASTM C916. All exposed leading edges and transverse joints shall be factory coated or coated with adhesive during fabrication.
3. Secure duct liner with mechanical fasteners, either weld-secured or impact-driven. Compress the duct liner sufficiently to hold it firmly in place. Adhesive bonded pins are not permitted. Space mechanical fasteners with respect to duct liner interior width as follows:
 - a. Maximum spacing for mechanical fasteners where air velocity is 0 – 2,500 FPM is as follows:
 1. From transverse end of liner: three (3) inches.
 2. Across width of duct: 12 inches on center.
 3. From corners of duct: four (4) inches.
 4. Along length of duct: 18 inches on center.
 - b. Maximum spacing for mechanical fasteners where air velocity is 2,501 – 5,000 FPM is as follows:
 1. From transverse end of liner: three (3) inches.
 2. Across width of duct: six (6) inches on center.
 3. From corners of duct: four (4) inches.
 4. Along length of duct: 16 inches on center.
4. Provide galvanized metal clips on all leading edges of duct liner. Exposed insulation is not acceptable.
5. Cut duct liner to ensure overlapped and compressed longitudinal corner joints.
6. Cut duct liner board to ensure tight, overlapped corner joints. Support the top pieces of liner board at the edges by the side pieces.
7. If the specification requires use of multiple insulation layers, take the following additional steps:
 - a. Affix bottom layer of duct liner in normal manner.
 - b. Affix top layer of duct liner to bottom layer using a minimum of 90% adhesive coverage.

- c. Treat the leading edges of the duct liner with galvanized angle clips to prevent separation of the 2 layers.
- d. Use mechanical fasteners of the proper length for the double layer.
- 8. Application: Provide duct liner as follows:
 - a. Provide duct liner in first 10 feet of duct from roof mounted exhaust fans.
 - b. Provide duct liner in all return air boots and transfer ducts.
 - c. Provide duct liner in the first 20 feet of supply and return duct from roof mounted air handling units / roof top units.

B. THERMAL INSULATION WRAP ON DUCT AND FITTINGS:

- 1. Before applying duct wrap, air ducts must be clean, dry, and tightly sealed at all joints and seams.
- 2. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.
- 3. To ensure installed thermal performance, duct wrap insulation shall be cut to "stretch-out" dimensions as shown in tables in manufacturer's literature.
- 4. Remove a two (2) inch piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.
- 5. Install duct wrap insulation with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the two (2) inch stapling and taping flap overlapping. On rectangular duct, install so insulation is not excessively compressed at corners. Staple seams approximately six (6) inches on center with 1/2-inch minimum steel outward clinching staples.
- 6. Seal seams and joints with glass fabric and mastic. Do not use cloth duct tape of any color or finish using reclaimed rubber adhesives on duct wrap insulation. Tightly butt adjacent sections of duct wrap with the two (2) inch tape flap overlapping.
- 7. Where rectangular ducts are 24 inches in width or greater, additionally secure duct wrap insulation to the bottom of the duct with mechanical fasteners such as pins and speed clip washers or cuphead weld pins, spaced on 18-inch centers (maximum) to prevent sagging of insulation. Do not overly compress insulation.
- 8. Seal all tears, punctures and other penetrations of the duct wrap facing using glass fabric and mastic.
- 9. Application: Provide duct wrap as follows:
 - a. All supply duct
 - b. All outside air supply and intake duct
 - c. All return air duct
 - d. All return air plenums on air units

- e. All intake plenums on outside air handling units
- f. All ductwork routed in un-conditioned spaces including but not limited to un-conditioned plenums (non-return air plenums), attics, exterior soffits, ventilated mechanical/boiler rooms and crawl spaces.

C. GREASE EXHAUST DUCT AND FITTINGS:

1. Provide one (1) or two (2) layers of Ductwrap to create a 2-hour rated duct enclosure. Each layer shall be lapped a minimum of three (3) inches. Inner layer shall be held in place with one (1) inch wide filament tape, spaced 1-1/2 inch from edges and midway at 10-1-2 centers. The outer layer shall be offset by 10-1/2 inches of inner layer, and one (1) inch wide filament tape shall be used in same manner as inner layer. 1/2-inch x 0.015-inch carbon steel banding strips on shall be installed same dimensions as tape to secure both layers on duct. All horizontal and vertical support hangers shall be wrapped with 1-layer of fire rated duct wrap and be secured with stainless steel ties or 1/2-inch hose clamps.
2. Access Door Installation: Four galvanized steel threaded rods, 1/4-inch diameter by 5 inches long are to be welded to the duct at the corners of the door opening. Four steel tubes, each 3 inches long, are placed over the rods to act as protection for the duct wrap when fastening the door. Four insulation pins are to be welded to the door panel for installation of the blanket. One layer of duct wrap is cut approximately the same size as the access panel and impaled over the insulation pins on the panel. It is essential that this layer fit tightly against the wrap surrounding the access door opening with no through openings. A second layer of duct wrap is cut to overlap the first layer by a minimum of one (1) inch. The second layer is impaled over the pins and both layers are locked in place with galvanized speed clips. Pins that extend beyond the outer layer of duct wrap shall be turned down to avoid sharp points. The insulated door panel is placed over the threaded rods and held in place with washers and wing nuts. Provide an access door at each change in duct direction and a minimum of every 10 feet on straight duct.
3. Filament tape can be used to temporarily hold the blanket in place until the banding is applied. The steel banding is applied around the duct 1-1/2 inch from edge of the blanket, and maximum 10-1/2-inch centers. The banding is placed around the material and tightened so as to sufficiently hold the duct wrap in place against the duct, compressing the foil but not cutting the foil.
4. Additional Pinning to Prevent Sagging of Wrap: For ducts 24 inches and larger in width, additional pins are needed to support the blanket on the bottom horizontal surface and on the outside face of a vertical duct run. Space pins a maximum of 10-1/2 inches apart in the direction of the blanket width, and a maximum of 12 inches apart in the direction of the blanket length.
5. Provide 12 ga copper-coated steel insulation pins with 1.5-inch square or round cup-head pins. Insulation pins are to be welded to ducts.
6. Duct Support Systems: Provide one layer of insulation to cover support components. Maintain 3-inch overlap.
7. Application:
 - a. Provide 2-hour enclosure on grease exhaust duct. Enclosure shall extend from kitchen hood to underside of roof deck.

D. INTERIOR EXPOSED DUCT

1. Duct shall be galvanized double wall insulated round or rectangular with perforated liner. Insulation shall be acrylic coated to prevent biological growth and airside erosion. Provide 1-1/2", 1.5 pcf (installed R-Value of 6.0) on interior exposed duct. Duct and fittings shall use a bolted flange with neoprene gasket at each connection. Provide factory seal at flange and duct. Visual sealant on exposed interior duct to be painted is unacceptable.
2. Round duct to be galvanized spiral lockseam type.
3. Exposed round duct shall utilize single rod hangers with angle support rings. Double rod hangers are only acceptable on concealed duct.
4. Application: Provide double wall duct as follows:
 - a. Gymnasiums
 - b. Natatoriums
 - c. Return air plenums with ducted connection to return grilles
 - d. Ducted connections to return air grilles
 - e. Any area where ductwork is exposed

3.3 FIELD QUALITY CONTROL

- A. Inspection: Upon completion of installation of the duct system and before operation is to commence, visually inspect the system and verify that it has been correctly installed.
- B. Contractor shall inspect systems during test and balance to ensure that the formation of condensation is not present. Contractor shall be responsible for damage caused by condensation.

3.4 PROTECTION

- A. Protect installed work from damage due to subsequent construction activity on the site.

3.5 INSULATION SCHEDULE

- A. Supply and return ducts routed indoors (Ambient temperature $\leq$ 85 degrees Fahrenheit, RH $\leq$ 70 percent): R-8.3 (minimum).
- B. Supply, return, and exhaust ducts routed in unconditioned spaces including but not limited to: un-conditioned plenums (non-return air plenums), attics, exterior soffits, mechanical/boiler rooms and crawl spaces. (Ambient temperature $\leq$ 95 degrees Fahrenheit, RH $\leq$ 70 percent): R-8.3 (minimum).
- C. Supply, return and exhaust ducts routed outdoors or in spaces where temperature and relative humidity exceed that specified for unconditioned spaces: R-8.3 (minimum).
- D. R-values represent installed values.
- E. Provide multiple layers of insulation or thicker insulation to achieve R-values listed. If multiple layers are utilized, inner insulation layer shall not include vapor retarder.

END OF SECTION 23 07 13

SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Pipe Insulation

1.3 SYSTEM DESCRIPTION

- A. Design Requirements: Provide pipe insulation systems which have been manufactured, fabricated, and installed to meet the current International Energy Conservation Code and all local amendments and criteria specified herein.
- B. Performance Requirements: Provide pipe insulation systems which have been manufactured, fabricated, and installed to meet the following criteria:
 - 1. NFPA 90A Installation of Air Conditioning and Ventilation Systems.

1.4 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by **highlighting** or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show specific pertinent performance data and quantities appropriate to scope of work.
- C. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
 - 1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - b. Detail attachment and covering of heat tracing inside insulation.
 - c. Detail insulation application at pipe expansion joints for each type of insulation.
 - d. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - e. Detail removable insulation at piping specialties.
 - f. Detail application of field-applied jackets.
 - g. Detail application at linkages of control devices.

1.5 QUALITY ASSURANCE

- A. Installation Qualifications: Utilize an installer having demonstrated (5) five years experience on projects of similar size and complexity.
- B. Condensation on any insulated piping system is not acceptable. Replace insulation damaged by condensation at no additional cost.
- C. All materials shall conform to Composite Surface Burning Characteristics (UL 723, ASTM E84):
 - 1. Flamespread: 25
 - 2. Smoke developed: 50
- D. All materials shall have U.L. label.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver insulation materials in manufacturer's original, unopened, undamaged containers with identification labels intact
- B. Contractor shall adequately protect insulation from damage after delivery to the project. Materials shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver materials to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Glass Fiber Pipe Insulation: Subject to compliance with plans and specification, provide one of the following:
 - 1. Johns Manville
 - 2. Owens Corning
 - 3. Knauf

4. Certainteed
- B. Cellular Glass Insulation: Subject to compliance with plans and specification, provide one of the following:
 1. Pittsburg Corning
 2. Cell-U-Foam
- C. Phenolic Foam Insulation: Subject to compliance with plans and specification, provide one of the following:
 1. Resolco
 2. Koolphen® K
- D. Aluminum Jacketing: Subject to compliance with plans and specification, provide one of the following:
 1. Childers
 2. Pabco
 3. RPR
- E. Fiberglass Reinforcing Cloth Mesh: Subject to compliance with plans and specification, provide one of the following:
 1. Perma Glass Mesh
 2. Alpha Glass Mesh
 3. Childers Chil-Glas
 4. Vimasco
- F. Mastics and Adhesives: Subject to compliance with plans and specification, provide one of the following:
 1. Childers
 2. Foster
 3. Vimasco

2.2 FIBERGLASS PIPE INSULATION

- A. High density factory molded fiberglass insulation with factory applied all service, and reinforced vapor retarder jacket. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. Provide thickness scheduled.
 1. Thermal conductivity "k" of 0.23 of Btu-in / hr-sq.ft. °F at 75-degree mean temperature.
 2. Maximum jacket permeance shall be 0.02.

2.3 CELLULAR GLASS INSULATION

- A. Rigid factory fabricated closed-cell pipe insulation:
 1. Thermal conductivity "k" of 0.32 Btu-in / hr-sq.ft. °F at 75-degree mean temperature.
 2. Density shall be an average of 8 lb/cu.ft.
 3. Maximum jacket permeance shall be 0.02.
 4. Compressive strength of 100 psi.

2.4 PHENOLIC FOAM INSULATION

- A. Rigid factory molded phenolic foam insulation with factory applied, all service, and reinforced vapor retarder jacket. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. Provide thickness scheduled.
 - 1. Thermal conductivity "k" of 0.18 btu-in / hr-sq.ft. °F at 75°-degree mean temperature.
 - 2. Maximum jacket permeance shall be 0.02.
 - 3. Compressive strength of 24 psi

2.5 ALUMINUM JACKET

- A. Jacket for piping shall be 0.016-inch-thick type 3105 aluminum with factory applied one mil polykraft moisture barrier.
- B. Fitting covers shall be factory made 0.024-inch type 1100 aluminum to match pipe covering.

PART 3 -EXECUTION

3.1 SITE INSPECTION

- A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.
- B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturer's recommendations.

3.2 PREPARATION

- A. Ensure that all pipe and fitting surfaces over which insulation is to be installed are clean and dry.
- B. Ensure that insulation is clean, dry and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.
- C. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.

3.3 INSTALLATION

- A. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
- B. Install insulation on piping subsequent to installation of heat tracing, painting, and acceptance tests.
- C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.

- D. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tears or other damage. All staples used on cold pipe insulation shall be coated with suitable sealant to maintain vapor barrier integrity.
- E. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
- F. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
- G. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- H. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.
- I. Apply multiple layers of insulation with longitudinal and end seams staggered.
- J. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- K. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.
- L. Keep insulation materials dry during application and finishing.
- M. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- N. Apply insulation with the least number of joints practical.
- O. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.
- P. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
- Q. Apply insulation continuously through hangers and around anchor attachments.
- R. For insulation application where vapor retarder is indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- S. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- T. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

- U. Insulation Terminations: For insulation application where vapor retarder is indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- V. Apply adhesives and mastics at the manufacturer's recommended coverage rate.
- W. Apply insulation with integral jackets as follows:
 - 1. Pull jacket tight and smooth.
 - 2. Circumferential Joints: Cover with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
 - 3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder
 - 4. Vapor-Retarder Mastics: Where vapor retarder is indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings, at penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.
 - 5. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.
 - a. Seal penetrations with vapor-retarder mastic
 - b. Apply insulation for exterior applications tightly joined to interior insulation ends.
 - c. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
 - d. Seal metal jacket to roof flashing with vapor-retarder mastic.
 - 6. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.
 - 7. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.
 - 8. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.
 - a. Fire stopping and fire-resistive joint sealers are specified in Division 7.
 - 9. Floor Penetrations: Apply insulation continuously through floor assembly.
 - a. For insulation with vapor retarder, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

X. Insulation Installation of Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 feet to form a vapor stop between pipe insulation segments.
3. For insulation with factory-applied jackets without integral vapor retarder, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

Y. Insulation Installation on Pipe Flanges:

1. Apply preformed cellular-glass pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cellular-glass block insulation.
4. Install jacket material with manufacturers recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

Z. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of molded cellular-glass insulation and match thickness to that of adjoining pipe. Fittings and fabricated segments shall be securely held in place with $\frac{1}{2}$ inch x 0.20-inch type 3105 aluminum bands.
 - a. After segments have been banded, apply a tack coat of insulating mastic to the insulated fitting to produce a smooth surface.
 - b. After mastic is dry, apply a second coat of vapor barrier mastic. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.
 - c. Overlap mastic and fiberglass cloth by 2 inches on adjoining sections of pipe insulation.

AA. Insulation Installation on Valves:

1. Install preformed two-piece factory molded cellular-glass insulation to valve body, match adjoining pipe insulation thickness. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. Install insulation to flanges as specified for flange insulation application.
 - a. After segments have been banded, apply a tack coat of insulating mastic to the insulated fitting to produce a smooth surface.

- b. After mastic is dry, apply a second coat of vapor barrier mastic. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.
- c. Overlap mastic and fiberglass cloth by 2 inches on adjoining sections of pipe insulation.

BB. PVC Cover:

- 1. Provide factory molded covers for all fittings, elbows and flanges.

3.4 FIELD-APPLIED JACKET APPLICATION

- A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
 - a. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - b. Embed 10 x 10 fiberglass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
 - c. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
- B. Apply foil and paper jackets where indicated.
 - a. Draw jacket material smooth and tight.
 - b. Apply lap or joint strips with the same material as jacket.
 - c. Secure jacket to insulation with manufacturer's recommended adhesive.
 - d. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints. Where vapor retarder is indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder mastic to ends of insulation at intervals of 15 feet to form a vapor stop between pipe insulation segments.
 - e. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

3.5 CHILLED WATER, HOT WATER, CONDENSATE DRAIN AND MISCELLANEOUS PIPING SYSTEMS

- A. Location: Indoor, conditioned spaces - return air plenums, air handling unit rooms
- B. Insulation Type:
 - 1. Heating Water and Condensate Piping: **Fiberglass**
 - 2. Chilled Water Piping: **Phenolic Foam**
- C. Support Inserts: At each support point, install a hard section of cellular glass (two halves) around entire circumference of piping, same thickness as adjacent insulation, to prevent compression at support bearing area. Sealed and finished to match the adjoining insulation. Cellular glass length shall overhang a minimum of 2" on both sides of the saddle. Refer to 3.5, E for saddle length requirements.

- D. Provide formed 16 ga. galvanized sheet-metal saddles with flared edges for protection of vapor retarder jacket and insulation. Saddles shall be short ribbed to secure saddle inside hanger, and prevention of saddle movement. Pipe saddles shall be secured on both ends with aluminum banding with a thickness of 0.20, 3/4" width and joined with 3/4" aluminum wing seals.
- E. Provide formed 16 ga. galvanized sheet-metal saddles as follows:
 - 3. Insert and saddle lengths:
 - a. 1-1/2 inch through 2-1/2-inch pipe - 10 inches Long
 - b. 3 inch through 6-inch pipe - 12 inches Long
 - c. 8 inch through 10-inch pipe - 16 inch Long
 - d. 12 inches and larger pipe - 22 inches Long
- F. Installation on Piping: All piping must be clean and dry at time of installation. Seal laps on jacket with adhesive. Provide 3-inch butt strips at each joint between sections and seal with adhesive.
- G. Provide vapor retarder on all cold-water piping. Install a sealed vapor stop every 15 feet.

3.6 CHILLED WATER, HOT WATER, CONDENSATION DRAIN AND MISCELLANEOUS PIPING SYSTEMS

- A. Location: Outdoor, un-conditioned spaces (non-return air plenums) and ventilated spaces. Shall include but not limited to: boiler rooms, non-return air plenum mechanical rooms, chiller rooms, and pump rooms.
- B. Insulation Type:
 - 1. Condensate Piping: **Fiberglass**
 - 2. Chilled Water and Heating Water Piping: **Phenolic Foam**
- C. Cellular Glass Installation:
 - 1. The insulation shall be applied to piping with all joints tightly butted. Joints may be rubbed slightly to achieve a tight fit. Seal all joints full depth with sealant. Insulation shall be secured with strips of fiber reinforced tape on 12-inch centers. The tape strips shall overlap by 50 percent.
 - 2. Apply asphalt mastic and 6 x 6 mesh fabric in accordance with manufacturer's recommended procedures.
 - 3. Aluminum jacketing shall be applied over the vapor retarder mastic with all laps positioned to shed water. All laps should overlap a minimum of 2 inches. Bands shall be spaced no greater than 12 inches on center.
 - 4. After asphalt mastic application, fittings shall be covered with prefabricated metal fitting covers supplied by aluminum jacketing supplier.
- D. Support Inserts: At each support point, install a hard section of cellular glass (two halves) around entire circumference of piping, same thickness as adjacent insulation, to prevent compression at support bearing area. Sealed and finished to match the adjoining insulation.

- E. Provide formed 14 ga. galvanized sheet-metal saddles with flared edges for protection of vapor retarder jacket and insulation. Saddles shall be short ribbed to secure saddle inside hanger, and prevention of saddle movement. Pipe saddles shall be secured on both ends with aluminum banding with a thickness of 0.20, $\frac{3}{4}$ " width and joined with $\frac{3}{4}$ " aluminum wing seals.
- F. Provide formed 14 ga. galvanized sheet-metal saddles as follows:
 - 1. Insert and saddle lengths:
 - a. 1-1/2 inch through 2-1/2-inch pipe - 10 inches Long
 - b. 3 inch through 6-inch pipe - 12 inches Long
 - c. 8 inch through 10-inch pipe - 16 inch Long
 - d. 12 inches and larger pipe - 22 inches Long
- G. Installation on Piping: All piping must be clean and dry at time of installation. Seal laps on jacket with adhesive and vapor retarder mastic. Provide 3-inch butt strips at each joint between sections and seal with adhesive.
- H. Provide vapor retarder on all cold-water piping. Install a sealed vapor stop every 15 feet.

3.7 ALUMINUM JACKET

- A. Install insulating materials per manufacturer's recommendations.
- B. Install aluminum jacketing per manufacturer's recommendations.
- C. Apply aluminum jacketing by lapping and sealing with caulking mastic and strapping with 1/2-inch x 0.20-inch Type 3105 aluminum bands on 12-inch centers.
- D. Use screws on vertical lines at circumferential joints. Space screws a maximum of 6 inches apart with a minimum of two screws per joint.
- E. Lap joints against weather so that water will run off lower edge.
- F. Use caulking mastic to seal circumferential laps on horizontal lines, longitudinal laps on vertical lines, and lap formed where aluminum jacketing meets mastic. Also seal any screws in jacketing.
- G. Prevent corrosion-causing galvanic action by ensuring that aluminum jacketing does not come in direct contact with other metals.
- H. Waterproof valve, flange, and fitting covers and irregular shapes with mastic.
- I. Paint mastic with one coat of aluminum paint. Paint exposed metal parts (i.e., uninsulated valves, flanges, and fittings) with one coat of aluminum paint.
- J. Pipe exposed in mechanical rooms and finished spaces less than 10 feet above finished floor shall have specified aluminum jacket for protection.
- K. All exterior pipes shall have specified aluminum jacket for protection.

3.8 PROTECTION

- A. Replace damaged aluminum jacketing and insulation, including insulation with vapor barrier damage and moisture-saturated insulation.
- B. The insulation contractor shall advise the general and / or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.9 INSULATION SCHEDULE

- A. Chilled water piping located within conditioned spaces.
 - 1. Insulation thickness (**Phenolic Foam**):
 - a. 1-1/2" thick insulation for: 1/2" through 2" pipe
 - b. 2" thick insulation for: 2-1/2" and larger pipe
- B. Chilled water and hot water piping located in un-conditioned or un-ventilated spaces and outdoors.
 - 1. Insulation thickness (**Phenolic Foam**):
 - a. 1-1/2" thick insulation for: 1/2" through 2" pipe
 - b. 2" thick insulation for: 2-1/2" and larger pipe
- C. Hot water piping located within conditioned spaces
 - 1. Insulation thickness: (**Fiberglass**):
 - a. 1-1/2" thick insulation for: 1/2" through 1-1/2" pipe
 - b. 2" thick insulation for: 2" and larger pipe
- D. Cold Condensate Drain Lines
 - 1. Insulation thickness: (**Fiberglass**):
 - a. 1" thick insulation for all pipe sizes and locations

END OF SECTION 23 07 19

SECTION 23 08 00 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Section 019114 "General Commissioning Requirements" for general commissioning process requirements.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.5 ALLOWANCES

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Section 012100 "Allowances."

1.6 UNIT PRICES

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Section 012200 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.7 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.

- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.9 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 - 6. Test and inspection reports and certificates.
 - 7. Corrective action documents.
 - 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least [10] days in advance of testing and balancing Work and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Subcontractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R **Subcontractor** shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to

Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.
 3. Minimum flushing water velocity.
 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of hot-water and solar systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- H. Refer to plans and specifications for HVAC system type.

END OF SECTION 23 08 00

EQUIPMENT SHALL BID AS AN ALTERNATE

SECTION 23 09 23 - DIRECT DIGITAL CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Heating and cooling piping:
 - 1. Control valves
 - 2. Flow meters
 - 3. Flow switches
 - 4. Press and temp sensor wells & sockets
 - 5. Temp sensor wells and sockets
- B. Duct accessories:
 - 1. Airflow stations
 - 2. BAS control dampers
 - 3. Terminal unit controls

1.3 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION

- A. Communications with Third Party Equipment:
 - 1. Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this section (reference sequence of operations and points list for specifics). Those systems include:
 - a. Boilers
 - b. Chillers
 - c. Cooling Towers
 - d. Switchgear
 - e. Variable Speed Drives
 - f. Computer Room Units (MDF)

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g. Rooftop Units

1.4 RELATED SECTIONS

- A. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.
- B. The following sections constitute related work:
 - 1. Division 01- General
 - 2. Division 23 – Mechanical
 - 3. Division 26 – Electrical

1.5 DESCRIPTION

- A. General: The control system shall consist of a complete BAS system with a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Depict each mechanical system and building floor plan by a point-and-click graphics. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface. If individual software seat licenses or keys are required provide a minimum of 4 additional licenses to accommodate multiple owner operators.
- B. If manufacture offers a web-based BAS platform, the installing contractor shall provide the new web-based software and software updates required for this project. Additionally, the installing contractor shall provide all computer related components (BAS web server – reference specifications for hardware requirements) for the new software platform to function in a peer-to-peer environment.
- C. The system shall directly control HVAC equipment as specified in Sequences of Operation. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints.
- D. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends, and alarms specified shall be BACnet objects.

1.6 APPROVED CONTROL SYSTEMS

- A. The following are approved control system suppliers, manufacturers, and product lines:
 - 1. **Refer to 01 23 00 ALTERNATES for acceptable manufacturers.**

1.7 QUALITY ASSURANCE

- A. Installer and Manufacturer Qualifications
 - 1. Installer shall have an established working relationship with Control System Manufacturer for a period of 10 years or greater. If the distributorship has not had

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- duration of more than 10 years, the contractor will not be approved without the written approval prior to bid date (no exceptions).
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.
3. BAS Graphics shall be Three Dimensional Thermographic.
4. BAS provider shall warranty controllers for 1 years.
5. BAS Provider shall provide lifetime training for the lifecycle of the facility to the owner at no additional cost.

1.8 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authority's codes and ordinances for these plans and specifications. At a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
 1. National Electric Code (NEC)
 2. International Energy Conservation Code (IECC)
 3. International Building Code (IBC)
 4. Uniform Mechanical Code (UMC)
 5. ASHRAE Standard 135-2016: BACnet - A Data Communication Protocol for Building Automation and Control Networks

1.9 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for operator workstation (server and browser for web-based systems).
 1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 seconds.
 2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 seconds and shall automatically refresh every 15 seconds.
 3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 seconds.
 4. Object Command. Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.

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5. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each workstation on the network shall receive alarms within 5 seconds of other workstations.
9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control. Control signal should be 0-10 vdc.

Control Stability and Accuracy. Control loops shall maintain measured variable at set point within tolerances listed in Table 2.

Table1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±2°F
Ducted Air	±2°F
Outside Air	±2°F
Dew Point	±3°F
Water Temperature	±2°F
Delta-T	±0.25°F
Relative Humidity	±5% RH
Water Flow	±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±1% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

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Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.2 in. w.g. ±0.01 in. w.g.	0-6 in. w.g. -0.1 to 0.1 in. w.g.
Airflow	±10% of full scale	
Space Temperature	±2.0°F	
Duct Temperature	±3°F	
Humidity	±5% RH	
Fluid Pressure	±1.5 psi ±1.0 in. w.g.	1-150 psi 0-50 in. w.g. differential

1.10 SUBMITTALS

- A. Product Requirements: Provide one electronic copy and 4 hard copies of shop drawings and other submittals on hardware, software, and equipment to be installed or furnished. Begin no work until submittals have been approved for conformity with design intent. If requested, provide drawings as AutoCAD 2017 and 4 prints of each drawing on 8.5 x 11 paper and 1 electronic copy of each drawing. When manufacturer's cut sheets apply to a product series rather than a specific product, **clearly indicate applicable data by highlighting** or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve Contractor of responsibility to supply sufficient quantities to complete work. Provide submittals on the following:

1. Direct Digital Control System Hardware
 - a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.
 - b. Manufacturer's description and technical data such as performance curves, product specifications, and installation and maintenance instructions for items listed below and for relevant items not listed below:
 1. Direct digital controllers (controller panels)
 2. Transducers and transmitters
 3. Sensors (include accuracy data)
 4. Actuators
 5. Valves
 6. Dampers
 7. Relays and switches
 8. Control panels

EQUIPMENT SHALL BID AS AN ALTERNATE

9. Power supplies
 10. Batteries
 11. Operator interface equipment
 12. Wiring
- c. Wiring diagrams and layouts for each control panel. Show termination numbers.
 - d. Floor plan schematic diagrams indicating field sensor and controller locations.
 - e. Riser diagrams showing control network layout, communication protocol, and wire types.
2. Central System Hardware and Software
 - a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.
 - b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under this contract not listed below:
 1. Central Processing Unit (CPU) or web server
 2. Monitors
 3. Keyboards
 4. Power supplies
 5. Battery backups
 6. Interface equipment between CPU or server and control panels
 7. Operating System software
 8. Operator interface software
 9. Color graphic software
 10. Third-party software
 - c. Schematic diagrams of control, communication, and power wiring for central system installation. Show interface wiring to control system.
 - d. Network riser diagrams of wiring between central control unit and control panels.

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3. Controlled Systems
 - a. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
 - b. Schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
 - c. Instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - d. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system. List I/O points and software points specified. Indicate alarmed and trended points.
 4. Description of process, report formats, and checklists to be used in Section 23 09 23 Article 3.15 (Control System Demonstration and Acceptance).
- B. Schedules
1. Within two months of contract award, provide schedule of work indicating:
 - a. Intended sequence of work items
 - b. Start date of each work item
 - c. Duration of each work item
 - d. Planned delivery dates for ordered material and equipment and expected lead times
 - e. Milestones indicating possible restraints on work by other trades or situations
 2. Monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated schedule of work.
- C. Project Record Documents. Submit 8 copies of record (as-built) documents upon completion of installation for approval prior to final completion. Submittal shall consist of:
1. Project Record Drawings. As-built versions of submittal shop drawings provided as AutoCAD 2017 and 6 prints of each drawing on 8 1/2" x 11" paper.
 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements of (Control System Demonstration and Acceptance).
 3. Operation and Maintenance (O&M) Manual. Printed, electronic, or online help documentation of the following:

EQUIPMENT SHALL BID AS AN ALTERNATE

- a. As-built versions of submittal product data.
 - b. Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Operator's manual with procedures for operating control systems: logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - d. Programming manual or set of 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.
 - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - f. Documentation of programs created using custom programming language including setpoints, tuning parameters, and object database. Electronic copies of programs shall meet this requirement if control logic, setpoints, tuning parameters, and objects can be viewed using furnished programming tools.
 - g. Graphic files, programs, and database on magnetic or optical media.
 - h. List of recommended spare parts with part numbers and suppliers.
 - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - j. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
 - k. Licenses, guarantees, and warranty documents for equipment and systems.
 - l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- D. Training Materials: The contractor shall provide training to owner personnel in a laboratory classroom environment. Each student shall be provided with a dedicated computer workstation utilizing a simulated BAS software platform that is installed for this project. The instructors shall have CEU accreditation for all training courses offered. Provide documentation for this requirement in the initial BAS submittal. If contractor does not have CEU instructor or offer these courses locally include cost for tuition, travel and boarding to send students to manufacturer training facility. The owner shall receive free training for the life of the system.

EQUIPMENT SHALL BID AS AN ALTERNATE

1. Operator Overview – Consists of general system navigation, scheduling functions, setpoint modifications and parameter adjustments.
2. Advanced Topics Overview – Detailed analysis of trend setup/configuration, trend historian, alarm setup, alarm actions (email, printing, etc.), point renaming, and detailed analysis of equipment parameters.
3. Program/Logic Manipulation – Modify system programs as needed for additions and modifications.
4. Graphic Manipulation – Modify system graphics as needed for additions and modifications.
5. Hardware Troubleshooting – Classroom setup shall have HVAC mock-up systems. Operators shall be able to interact with this live system through the BAS utilized for this project. Class will provide students the ability to identify and repair common problems regularly encountered.
6. Software Troubleshooting - Classroom setup shall have HVAC mock-up systems. Operators shall be able to interact with this live system through the BAS utilized for this project. Class will provide students the ability to identify and repair common issues that can be utilized via software modifications.
7. Central Plant Operation – At a minimum the instructor shall thoroughly explain different types of central plant equipment and proper system modifications that can be made to enhance system performance and energy savings.
8. HVAC System Training – Objective of this class is to provide basic HVAC system knowledge of various types of systems including types of air side distribution and water side distribution. Topics such as thermodynamics, psychometrics, de-humidification, and demand control ventilation shall be thoroughly explained.

1.11 WARRANTY

A. Warrant work as follows:

1. Warrant materials for specified control system and peripheral control devices free from defects for a period of **1 years** after certificate of substantial completion. Warrant all labor for a period of **1 year** after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request. Additionally, contractor shall offer 24/7 after-hours support to include alarm monitoring and associated dispatch service.
2. Provide graphic modifications for a period of 3 years from date of substantial completion. This shall include room number and equipment modifications as requested by the owner.
3. Provide telephone support free to the owner for a period of 3 years after substantial completion. This service includes technical support for all BAS equipment and shall include troubleshooting and problem resolution via the

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telephone or web services. Service shall be available during the hours of 7am to 5pm Monday – Friday.

4. Work shall have a single warranty date, even if Owner receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
5. Provide updates to operator workstation or web server software, project-specific software, graphic software, database software, and firmware that resolve Contractor or Owner identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
6. Exception: Contractor shall not be required to warranty existing devices except those that have been rebuilt or repaired during installation.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

- A. Project-specific software and documentation shall become Owner's property. This includes, but is not limited to:
 1. Graphics
 2. Record drawings
 3. Database
 4. Application programming code
 5. Documentation

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ASHRAE/ANSI Standard 135-2016, BACnet.
- B. Use existing Ethernet backbone for network segments marked "existing" on project drawings.

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- C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
 - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
 - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in Sequence of Operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.
- E. Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.
- G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards specified by the Web Services Interoperability Organization (WS-I) Basic Profile 1.0 or higher. Web services support shall as a minimum be provided at the workstation or web server level and shall enable the system to both read and write data.
 - 1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
 - 2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
 - 3. For read or write requests, the system shall require username and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.

2.3 OPERATOR INTERFACE

- A. Operator Interface. Web server shall reside on high-speed network with building controllers. Each standard browser connected to server shall be able to access all system information. Existing manufacturer's BAS web server and workstation can be utilized. In addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and

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viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). This secondary interface may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:

1. An operator authentication system that requires an operator to log in before viewing or editing any data, and which can be configured to limit the privileges of an individual operator.
 2. The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.
 3. A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.
 4. Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system and then return to the home screen. These links may be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building, and then to a specific room or piece of equipment.
- B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2016, BACnet Annex J.
- C. Hardware. If providing a new server, each workstation or web server shall consist of the following:
1. Hardware Base. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet response times specified in Section 23 09 23 Paragraph 1.8. Hard disk shall have sufficient memory to store system software, one year of data for trended points specified in Sequences of Operation, and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance. Web server shall be Compaq Rack Mounted Server (or equal) with a minimum of:
 - a. Dual Processor Intel Pentium 3.66 GHz processor
 - b. 1 GB RAM
 - c. 80 GB hard disk providing data at 100 MB/sec
 - d. RAID 5 Configuration
 - e. 128x CD-ROM drive

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- f. Most Current Windows Server Operating System
 - g. Serial, parallel, and network communication ports and cables required for proper system operation.
 - 2. If providing a server, the server shall support one or more the following database types:
 - a. SQL Server 2012 R2
 - b. PostgreSQL
 - c. MySQL
 - d. MS Access
- D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:
 - 1. Log In and Log Out. System shall require username and password to log in to operator interface.
 - 2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
 - 3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls, and sensor calibration.
 - 4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period, and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
 - 5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm, and to clear (delete) unneeded alarms.
 - 6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
 - 7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results, and to customize report configuration to show data of interest.
 - 8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller, and to download new control software to each controller.
 - 9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators, and to edit

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operator function authorization. Operator shall be able to authorize each operator function separately.

E. System Software.

1. Operating System: Web server or workstation shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows XP Pro, Red Hat Linux, or Sun Solaris.
2. System Graphics: Operator interface shall be graphically based and shall include at least one graphic per piece of equipment or occupied zone, graphics for each chilled water and hot water system, and graphics that summarize conditions on each floor of each building included in this contract. Indicate thermal comfort on floor plan summary graphics using dynamic colors to represent zone temperature relative to zone setpoint. Graphics shall
 - a. Functionality: Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment, and to edit setpoints and other specified parameters.
 - b. Animation: Graphics shall be able to animate by displaying different image files for changed object status.
 - c. Alarm Indication: Indicate areas or equipment in an alarm condition using color or other visual indicator.
 - d. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

F. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.
2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.
3. System Configuration. Operators shall be able to configure the system.
4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

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5. Security. System shall require a username and password to view, edit, add, or delete data.
 - a. Operator Access. Each username and password combination shall define accessible viewing, editing, adding, and deleting functions in each system application, editor, and object. Authorized operators shall be able to vary and deny each operator's accessible functions based on equipment or geographic location.
 - b. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.
 - c. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.
6. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).
7. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Section 23 09 93. Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
8. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
9. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page, and audibly annunciate.
10. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
11. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. The contractor shall configure all physical control points and software control points to accumulate trend data. Analog values shall be configured utilizing time-based intervals and digital values shall be configured for COV. Provide at a minimum of 250 samples per control point. If data can be stored locally at the controller level, this information shall be archived at the central server or all BAS workstations.

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12. Object and Property Status and Control. Operator shall be able to view, and to edit if applicable, the status of each system object and property by menu, on graphics, or through custom programs.
13. Reports and Logs. Operator shall be able to select, to modify, to create, and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.
14. Standard Reports. Furnish the following standard system reports:
 - a. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location, or by combination of filter criteria.
 - b. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.
 - c. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:
 1. Alarm History.
 2. Trend Data. Operator shall be able to select trends to be logged.
 3. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes, and alarm acknowledgment and deletion. System shall date and time stamp logged activity.
15. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations, and that present results in tabular or graphical format. Reports shall be launched from the operator interface.
16. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics, and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text, and animation files to a background graphic using a mouse.
17. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. Library graphic file format shall be compatible with graphics generation tools.
18. Custom Application Programming. Operator shall be able to create, edit, debug, and download custom programs. System shall be fully operable while custom programs are edited, compiled, and downloaded. Programming language shall have the following features:
 - a. Language. Language shall be graphically based or English language oriented. If graphically based, language shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below, and

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operators shall be able to create custom or compound function blocks. If English language oriented, language shall be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and shall allow for free-form programming that is not column-oriented or "fill-in-the-blanks."

- b. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify, and delete custom programming code, and to copy blocks of code to a file library for reuse in other control programs.
 - c. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.
 - d. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators, and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.
 - e. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR, and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - f. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division, and square root operations, as well as absolute value calculation and programmatic selection of minimum and maximum values from a list of values.
 - g. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.
 - 1. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year, and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours, and days. Operator shall be able to start, stop, and reset elapsed time variables using the program language.
 - 2. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable, and change setpoints of Controller Software as described in Controller Software section.
19. BACnet. Web server or workstation shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2016, BACnet Annex L.

2.4 CONTROLLER SOFTWARE

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- A. Building and energy management application software shall reside and operate in system controllers. Applications shall be editable through operator workstation, web browser interface, or engineering workstation.
- B. System Security. See Paragraph 2.3.F.5 (Security) and Paragraph 2.3.F.14.c.3 (Operator Activity).
- C. Scheduling. See Paragraph 2.3.D.4 (View and Adjust Operating Schedules). System shall provide the following schedule options as a minimum:
 - 1. Weekly. Provide separate schedules for each day of the week. Each schedule shall be able to include up to 5 occupied periods (5 start-stop pairs or 10 events).
 - 2. Exception. Operator shall be able to designate an exception schedule for each of the next 365 days. After an exception schedule has executed, system shall discard and replace exception schedule with standard schedule for that day of the week.
 - 3. Holiday. Operator shall be able to define 24 special or holiday schedules of varying length on a scheduling calendar that repeats each year.
- D. System Coordination. Operator shall be able to group related equipment based on function and location and to use these groups for scheduling and other applications.
- E. Binary and Analog Alarms. See Paragraph 2.3.F.7 (Alarm Processing).
- F. Alarm Reporting. See Paragraph 2.3.F.9 (Alarm Reactions).
- G. Remote Communication. System shall automatically contact operator workstation or server on receipt of critical alarms. If no network connection is available, system shall use a modem connection.
- H. Maintenance Management. System shall generate maintenance alarms when equipment exceeds adjustable runtime, equipment starts, or performance limits. Configure and enable maintenance alarms as specified in Section 23 09 93.
- I. Sequencing. Application software shall sequence chillers, boilers, and pumps as specified in Section 23 09 93.
- J. PID Control. System shall provide direct- and reverse-acting PID (proportional-integral-derivative) algorithms. Each algorithm shall have anti-windup and selectable controlled variable, setpoint, and PID gains. Each algorithm shall calculate a time-varying analog value that can be used to position an output or to stage a series of outputs.
- K. Staggered Start. System shall stagger controlled equipment restart after power outage. Operator shall be able to adjust equipment restart order and time delay between equipment restarts.
- L. Energy Calculations.
 - 1. System shall accumulate and convert instantaneous power (kW) or flow rates (gpm) to energy usage data.

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2. System shall calculate a sliding-window average (rolling average). Operator shall be able to adjust window interval to 15 minutes, 30 minutes, or 60 minutes.
 3. System shall calculate a fixed-window average. Window interval start shall be defined by utility meter digital input signal to synchronize system's and utility's fixed-window averages.
- M. Anti-Short Cycling. Binary output objects shall be protected from short cycling by means of adjustable minimum on-time and off-time settings.
- N. On and Off Control with Differential. System shall provide direct- and reverse-acting on and off algorithms with adjustable differential to cycle a binary output based on a controlled variable and setpoint.
- O. Runtime Totalization. System shall provide an algorithm that can totalize runtime for each binary input and output. Operator shall be able to enable runtime alarm based on exceeded adjustable runtime limit. Configure and enable runtime totalization and alarms as specified.

2.5 CONTROLLERS

- A. General. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), and Smart Actuators (SA) as required to achieve performance specified in Section 23 09 23 Article 1.8 (System Performance).
- B. BACnet.
1. Building Controllers (BCs). Each BC shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ASHRAE/ANSI 135-2016, BACnet Annex L.
 2. Advanced Application Controllers (AACs). Each AAC shall conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ASHRAE/ANSI 135-2016, BACnet Annex L and shall be listed as a certified B-AAC in the BACnet Testing Laboratories (BTL) Product Listing.
 3. Application Specific Controllers (ASCs). Each ASC shall conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ASHRAE/ANSI 135-2016, BACnet Annex L and shall be listed as a certified B-ASC in the BACnet Testing Laboratories (BTL) Product Listing.
 4. Smart Actuators (SAs). Each SA shall conform to BACnet Smart Actuator (B-SA) device profile as specified in ASHRAE/ANSI 135-2016, BACnet Annex L and shall be listed as a certified B-SA in the BACnet Testing Laboratories (BTL) Product Listing.
 5. BACnet Communication.
 - a. Each BC shall reside on or be connected to a BACnet network using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing.

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- b. BACnet routing shall be performed by BCs or other BACnet device routers as necessary to connect BCs to networks of AACs and ASCs.
 - c. Each AAC and ASC shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
 - d. Each SA shall reside on a BACnet network using the ARCNET or MS/TP Data Link/Physical layer protocol.
- C. Communication.
 - 1. Service Port. Each controller shall provide a service communication port for connection to a Portable Operator's Terminal. Connection shall be extended to space temperature sensor ports where shown on drawings.
 - 2. Signal Management. BC and ASC operating systems shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and to allow for central monitoring and alarms.
 - 3. Data Sharing. Each BC and AAC shall share data as required with each networked BC and AAC.
 - 4. Stand-Alone Operation. Each piece of equipment specified in Sequences of Operation shall be controlled by a single controller to provide stand-alone control in the event of communication failure. All I/O points specified for a piece of equipment shall be integral to its controller. Provide stable and reliable stand-alone control using default values or other method for values normally read over the network.
- D. Environment. Controller hardware shall be suitable for anticipated ambient conditions.
 - 1. Controllers used outdoors or in wet ambient conditions shall be mounted in waterproof enclosures and shall be rated for operation at -20°F to 140°F.
 - 2. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32°F to 120°F.
- E. Real-Time Clock. Controllers that perform scheduling shall have a real-time clock.
- F. Serviceability.
 - 1. Controllers shall have diagnostic LEDs for power, communication, and processor.
 - 2. Wires shall be connected to a field-removable modular terminal strip or to a termination card connected by a ribbon cable.
 - 3. Each BC and AAC shall continually check its processor and memory circuit status and shall generate an alarm on abnormal operation. System shall continuously check controller network and generate alarm for each controller that fails to respond.

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- G. Memory.
 - 1. Controller memory shall support operating system, database, and programming requirements.
 - 2. Each BC and AAC shall retain BIOS and application programming for at least 72 hours in the event of power loss.
 - 3. Each ASC and SA shall use nonvolatile memory and shall retain BIOS and application programming in the event of power loss. System shall automatically download dynamic control parameters following power loss.
- H. Immunity to Power and Noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft.).
- I. Transformer. ASC power supply shall be fused or current limiting and shall be rated at a minimum of 125% of ASC power consumption.

2.6 INPUT AND OUTPUT INTERFACE

- A. General. Hard-wire input and output points to BCs, AACs, ASCs, or SAs.
- B. Protection. Shorting an input or output point to itself, to another point, or to ground shall cause no controller damage. Input or output point contact with up to 24 V for any duration shall cause no controller damage.
- C. Binary Inputs. Binary inputs shall monitor the on and off signal from a remote device. Binary inputs shall provide a wetting current of at least 12 mA and shall be protected against contact bounce and noise. Binary inputs shall sense dry contact closure without application of power external to the controller.
- D. Pulse Accumulation Inputs. Pulse accumulation inputs shall conform to binary input requirements and shall accumulate up to 10 pulses per second.
- E. Analog Inputs. Analog inputs shall monitor low-voltage (0-10 Vdc), current (4-20 mA), or resistance (thermistor or RTD) signals. Analog inputs shall be compatible with and field configurable to commonly available sensing devices.
- F. Binary Outputs. Binary outputs shall send a pulsed low-voltage signal for pulse width modulation control or an on-or-off signal for on and off control. Building Controller binary outputs shall have three-position (on-off-auto) override switches and status lights. Outputs shall be selectable for normally open or normally closed operation.
- G. Analog Outputs. Analog outputs shall send a modulating 0-10 Vdc or 4-20 mA signal as required to properly control output devices. Each Building Controller analog output shall have a two-position (auto-manual) switch, a manually adjustable potentiometer, and status lights. Analog outputs shall not drift more than 0.4% of range annually.
- H. Tri-State Outputs. Control three-point floating electronic actuators without feedback with tri-state outputs (two coordinated binary outputs). Tri-State outputs may be used to

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provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.

- I. Pulse-Width Modulation. Control actuators designed for pulse-width modulation with a single binary output that cycle with variable on and off times as determined by the application software. Pulse-width modulation may be used to provide analog output control in zone control and terminal unit control applications such as VAV terminal units, duct-mounted heating coils, and zone dampers.
- J. Universal Inputs and Outputs. Inputs and outputs that can be designated as either binary or analog in software shall conform to the provisions of this section that are appropriate for their designated use.

2.7 POWER SUPPLIES AND LINE FILTERING

- A. Power Supplies. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - 1. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand 150% current overload for at least three seconds without trip-out or failure.
 - a. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 - b. Line voltage units shall be UL recognized and CSA listed.
- B. Power Line Filtering.
 - 1. Provide internal or external transient voltage and surge suppression for workstations and controllers. Surge protection shall have:
 - a. Dielectric strength of 1000 V minimum
 - b. Response time of 10 nanoseconds or less
 - c. Transverse mode noise attenuation of 65 dB or greater
 - d. Common mode noise attenuation of 150 dB or greater at 40-100 Hz

2.8 AUXILIARY CONTROL DEVICES

- A. Motorized Control Dampers.
 - 1. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
 - a. Outdoor and return air mixing dampers and face-and-bypass dampers shall be parallel-blade and shall direct airstreams toward each other.

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- b. Other modulating dampers shall be opposed-blade.
 - c. Two-position shutoff dampers shall be parallel or opposed-blade with blade and side seals.
 - 2. Frame. Damper frames shall 16-gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.
 - 3. Blades. Damper blades shall not exceed 8 inches in width or 48 inches in length. Blades shall be suitable for medium velocity (2000 fpm) performance. Blades shall be not less than 16 gauge.
 - 4. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
 - 5. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than (10 cfm per ft ²) at (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of (1500 fpm).
 - 6. Sections. Damper sections shall not exceed 48 in. - 60 in. Each section shall have at least one damper actuator.
 - 7. Linkages. Dampers shall have exposed linkages.
- B. Electric Damper and Valve Actuators.
- 1. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
 - 2. Spring-return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
 - 3. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range.
 - 4. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
 - 5. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 60 inch -lb torque capacity shall have a manual crank.
 - 6. Acceptable Manufacturers:
 - a. Belimo
- C. Control Valves.
- 1. General. Select body and trim materials in accordance with manufacturer's recommendations for design conditions and service shown.

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2. Type. Provide two or three-way control valves for two-position or modulating service as shown.
3. Water Valves.
 - a. Valves providing two-position service shall be quick opening. Two-way valves shall have replaceable disc or ball.
 - b. Close-off (Differential) Pressure Rating. Valve actuator and trim shall provide the following minimum close-off pressure ratings.
 1. Two-way: 100% of total system (pump) head.
 2. Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - c. Ports. Valves providing modulating service shall have equal percentage ports.
 - d. Sizing.
 1. Two-position service: line size.
 2. Two-way modulating service: select pressure drop equal to the greatest of twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa (5 psi).
 3. Three-way modulating service: select pressure drop equal to the smaller of twice the pressure drop through the coil exchanger (load) or 35 kPa (5 psi).
 4. Two-way and three-way modulating valve shall be one or two sizes smaller than the pipe size.
 - e. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
 1. Water zone valves: normally closed.
 2. Heating coils in air handlers: normally closed.
 3. Chilled water control valves: normally open.
 4. Other applications: as scheduled or as required by sequences of operation.
 - f. Acceptable Valve and Actuator Manufacturers:
 1. Belimo
- D. Binary Temperature Devices.

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1. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
2. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating, concealed setpoint adjustment, 55°F-85°F setpoint range, 2°F maximum differential, and vented ABS plastic cover.
3. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall be at least 20 ft long. Element shall sense temperature in each 1 ft section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.

E. Temperature Sensors.

1. Type. Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
2. Duct Sensors. Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 5 ft in length per 10 ft² of duct cross-section.
3. Immersion Sensors. Provide immersion sensors with a separable stainless steel well. Well pressure rating shall be consistent with system pressure it will be immersed in. Well shall withstand pipe design flow velocities.
4. Space Sensors: Space sensors shall be stainless steel flush plate mounted type.
5. Differential Sensors. Provide matched sensors for differential temperature measurement.

F. Humidity Sensors.

1. Duct and room sensors shall have a sensing range of 20%-80%.
2. Duct sensors shall have a sampling chamber.
3. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH and shall be suitable for ambient conditions of 40°F-170°F.
4. Humidity sensors shall not drift more than 1% of full scale annually.

G. Flow Switches. Flow-proving switches shall be thermal dispersion type (IFM U 40100 or approved equal) or differential pressure type (air or water service). Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

1. Thermal dispersion type switches shall have relay output, wire break output and temperature output.

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2. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 4 enclosure unless otherwise specified.
- H. Relays.
1. Control Relays. Control relays shall be plug-in type, UL listed and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 2. Time Delay Relays. Time delay relays shall be solid-state plug-in type, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.
- I. Override Timers.
1. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified. Flush mount timer on local control panel face or where shown.
- J. Current Transmitters.
1. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500-ohm maximum burden.
 2. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
 3. Unit shall be split-core type for clamp-on installation on existing wiring.
- K. Current Transformers.
1. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
 2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 3. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.
- L. Voltage Transmitters.
1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.

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2. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500-ohm maximum burden.
 3. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.
- M. Voltage Transformers.
1. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
 2. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
 3. Windings (except for terminals) shall be completely enclosed with metal or plastic.
- N. Power Monitors.
1. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
 2. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.
- O. Current Switches.
1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. Select switches to match application current and DDC system output requirements.
- P. Pressure Transducers.
1. Transducers shall have linear output signal and field-adjustable zero and span.
 2. Continuous operating conditions of positive or negative pressure 50% greater than calibrated span shall not damage transducer sensing elements.
 3. Water pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Transducer shall have 4-20 mA output, suitable mounting provisions, and block and bleed valves.
 4. Water differential pressure transducer diaphragm shall be stainless steel with minimum proof pressure of 1000 kPa (150 psi). Over-range limit (differential pressure) and maximum static pressure shall be 2000 kPa (300 psi.) Transducer shall have 4-20 mA output, suitable mounting provisions, and 5-valve manifold.
- Q. Differential Pressure Switches. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

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- R. Pressure-Electric (PE) Switches. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).
 - 1. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
 - 2. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
 - 3. Each pneumatic signal line to PE switches shall have permanent indicating gauge.
- S. Local Control Panels.
 - 1. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
 - 2. Prewire internal and face-mounted device connections with color-coded stranded conductors tie-wrapped or neatly installed in plastic troughs. Field connection terminals shall be UL listed for 600 V service, individually identified per control and interlock drawings, with adequate clearance for field wiring.
 - 3. Each local panel shall have a control power source power switch (on-off) with overcurrent protection.

2.9 WIRING AND RACEWAYS

- A. General. Provide copper wiring, plenum cable, and raceways as specified in applicable sections of Division 26.
- B. Insulated wire shall use copper conductors and shall be UL listed for 90°C (200°F) minimum service.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Thoroughly examine project plans for control device and equipment locations. Report discrepancies, conflicts, or omissions to Architect or Engineer for resolution before starting rough-in work.
- B. Inspect site to verify that equipment can be installed as shown. Report discrepancies, conflicts, or omissions to Engineer for resolution before starting rough-in work.
- C. Examine drawings and specifications for work of others. Report inadequate headroom or space conditions or other discrepancies to Engineer and obtain written instructions for changes necessary to accommodate Section 23 09 23 work with work of others. Controls

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Contractor shall perform at his expense necessary changes in specified work caused by failure or neglect to report discrepancies.

3.2 PROTECTION

- A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
- B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site.
 - 1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Submittals. See Section 23 09 23 Article 1.9 (Submittals).
- C. Test and Balance.
 - 1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
 - 2. Train Test and Balance Contractor to use control system interface tools.
 - 3. Provide a qualified technician to assist with testing and balancing the first 20 terminal units.
 - 4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.
- D. Life Safety.
 - 1. Duct smoke detectors required for air handler shutdown are provided and wired under Division 26.
 - 2. Smoke dampers and actuators required for duct smoke isolation are provided under Division 23 and wired by Division 26.
 - 3. Fire and smoke dampers and actuators required for fire-rated walls are provided under Division 23. Fire and smoke damper control is provided under Division 26.
- E. Coordination with Other Controls. Integrate with and coordinate controls and control devices furnished or installed by others as follows.

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1. Communication media and equipment shall be provided as specified in Section 23 09 23 Article 2.2 (Communication).
2. Each supplier of a control's product shall configure, program, start up, and test that product to meet the sequences of operation described regardless of where within the contract documents those products are described.
3. Coordinate and resolve incompatibility issues that arise between control products provided under this section and those provided under other sections or divisions of this specification.
4. Controls Contractor shall be responsible for integration of control products provided by multiple suppliers regardless of where integration is described within the contract documents.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- B. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- C. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- D. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- E. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.5 FIELD QUALITY CONTROL

- A. Commissioning and start-up of the BAS system shall be performed factory certified employees of the BAS contractor or manufacturer. Under no instances shall electrical subcontractors perform this work.
- B. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section 23 09 23 Article 1.7 (Codes and Standards).
- C. Continually monitor field installation for code compliance and workmanship quality.
- D. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.6 WIRING

- A. To differentiate BAS wiring from that of other trades, all cable except for underground will have a **yellow outer jacket** (no exceptions).
- B. Division 26 contractor shall supply a dedicated 120vac power to a junction box in each mechanical room for use by the BMCS.

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- C. A Conduit fill based on plenum 18-gauge 2 conductor:
 - 1. 1/2 inch - No more than 4 conductors.
 - 2. 3/4 inch - No more than 8 conductors.
 - 3. 1 inch - No more than 12 conductors.
- D. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26, and manufacturer's recommendations. Where the requirements of Section 23 09 23 differ from Division 26, Section 23 09 23 shall take precedence.
- E. All wires whether control network or device wire shall be marked with Brady-type markers.
- F. NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway as specified by NEC and Division 26.
- G. Low-voltage wiring shall meet NEC Class 2 requirements. Sub-fuse low-voltage power circuits as required to meet Class 2 current limit.
- H. NEC Class 2 (current-limited) wires not in raceway but in concealed and accessible locations such as return air plenums shall be UL listed for the intended application.
- I. Install wiring in raceway where subject to mechanical damage and at levels below 10ft. in mechanical, electrical, or service rooms.
- J. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- K. Install Class 1 and Class 2 wiring in separate raceways. Boxes and panels containing high-voltage wiring and equipment shall not be used for low-voltage wiring except for the purpose of interfacing the two through relays and transformers.
- L. Do not install wiring in raceway containing tubing.
- M. Run exposed Class 2 wiring parallel to a surface or perpendicular to it and tie neatly at (5 ft) intervals.
- N. Contractor shall install all low voltage communication wiring as per all TIA/EIA communication cabling standards. All cabling shall be installed in dedicated cabling support such as j-hook, d-rings, or saddles. All supports shall be supported directly from building structure. Do not support cabling or supports from ceiling grid wire, conduit, ductwork, piping, or other system cabling. All cabling must be installed in independent support for that given system and may not share supports or run-in same conduit or support. All cabling shall be supported every 5'-0" from approved cabling support method. Contractor shall bundle all system cabling and label all wiring for system they serve. All cabling passing thru walls shall require dedicated conduit sleeves with bushing to protect cabling during installation. Contractor shall provide 1 meter service loops at all device termination locations and 3-meter service loops at all head end termination locations. All low voltage HVAC control cabling shall be yellow in color unless specified otherwise. Do

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- not use ductwork, electrical raceways, piping, or ceiling suspension systems to support or anchor cables.
- O. Secure raceways with raceway clamps fastened to structure and spaced according to code requirements. Raceways and pull boxes shall not be hung on or attached to ductwork, electrical raceways, piping, or ceiling suspension systems.
 - P. Size raceway and select wire size and type in accordance with manufacturer's recommendations and NEC requirements.
 - Q. Include one pull string in each raceway 2.5 cm (1 in.) or larger.
 - R. Use color-coded conductors throughout.
 - S. Locate control and status relays in designated enclosures only. Do not install control and status relays in packaged equipment control panel enclosures containing Class 1 starters.
 - T. Conceal raceways except within mechanical, electrical, or service rooms. Maintain minimum clearance of 15 cm (6 in.) between raceway and high-temperature equipment such as steam pipes or flues.
 - U. Adhere to requirements in Division 26 where raceway crosses building expansion joints.
 - V. Install insulated bushings on raceway ends and enclosure openings. Seal top ends of vertical raceways.
 - W. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
 - X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft.) in length and shall be supported at each end. Do not use flexible metal raceway less than ½ in. electrical trade size.
 - Y. Install raceway rigidly, support adequately, ream at both ends, and leave clean and free of obstructions. Join raceway sections with couplings and according to code. Make terminations in boxes with fittings. Make terminations not in boxes with bushings.

3.7 COMMUNICATION WIRING

- A. Communication wiring shall be low-voltage Class 2 wiring and shall comply with Article 3.7 (Wiring).
- B. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- C. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- D. Verify entire network's integrity following cable installation using appropriate tests for each cable.

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- E. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- F. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- G. Label communication wiring to indicate origination and destination.
- H. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 FIBER OPTIC CABLE

- A. During installation do not exceed maximum pulling tensions specified by cable manufacturer. Post-installation residual cable tension shall be within cable manufacturer's specifications.
- B. Install cabling and associated components according to manufacturers' instructions. Do not exceed minimum cable and unjacketed fiber bend radii specified by cable manufacturer.

3.9 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.
- C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
- F. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft. of sensing element for each 1 ft. ² of coil area.
- G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- I. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.

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2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.
 4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.
 5. Pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
 6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
- J. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.10 FLOW SWITCH INSTALLATION

- A. Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

- A. General. Mount actuators and adapters according to manufacturer's recommendations.
- B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten linkage.
 3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 4. Provide necessary mounting hardware and linkages for actuator installation.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

- A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 5 cm (2 in.) of termination.

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- B. Label pneumatic tubing at each end within 5 cm (2 in.) of termination with a descriptive identifier.
- C. Permanently label or code each point of field terminal strips to show instrument or item served.
- D. Label control panels with minimum 1 cm (½ in.) letters on laminated plastic nameplates.
- E. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.
- F. Label valves with nameplates.
- G. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- H. Label identifiers shall match record documents.

3.13 PROGRAMMING

- A. Point Naming. Name points as shown on the equipment points list provided with each Sequence of Operation. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.
- B. All DDC programming shall be accomplished through graphical programming, line code is unacceptable
- C. Software Programming. Programming shall provide actions for each possible situation. Graphic- or parameter-based programs shall be documented.
 - 1. Application Programming. Provide application programming that adheres to sequences of operation specified in Section 23 09 93. Program documentation or comment statements shall reflect language used in sequences of operation.
 - 2. System Programming. Provide system programming necessary for system operation.
- D. Operator Interface.
 - 1. Standard Graphics. Provide graphics as specified in Section 23 09 23 Article 2.3 Paragraph E.2 (System Graphics). Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List located in the Sequence of Operation. Point information on graphics shall dynamically update.
 - 2. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation) as described in Section 23 09 23.
 - 3. DDC screen graphic room numbers shall be based on final room graphics package. Obtain Architect/Owner approval of final room numbers prior to programming.

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3.14 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Startup Testing. Complete startup testing to verify operational control system before notifying Owner of system demonstration. Provide Owner with schedule for startup testing. Owner may have representative present during any or all startup testing.
1. Calibrate and prepare for service each instrument, control, and accessory equipment furnished under Section 23 09 23.
 2. Verify that control wiring is properly connected and free of shorts and ground faults. Verify that terminations are tight.
 3. Enable control systems and verify each input device's calibration. Calibrate each device according to manufacturer's recommendations.
 4. Verify that binary output devices such as relays, solenoid valves, two-position actuators and control valves, and magnetic starters, operate properly and that normal positions are correct.
 5. Verify that analog output devices such as I/Ps and actuators are functional, that start and span are correct, and that direction and normal positions are correct. Check control valves and automatic dampers to ensure proper action and closure. Make necessary adjustments to valve stem and damper blade travel.
 6. Prepare a log documenting startup testing of each input and output device, with technician's initials certifying each device has been tested and calibrated.
 7. Verify that system operates according to sequences of operation. Simulate and observe each operational mode by overriding and varying inputs and schedules. Tune PID loops and each control routine that requires tuning.
 8. Alarms and Interlocks.
 - a. Check each alarm with an appropriate signal at a value that will trip the alarm.
 - b. Trip interlocks using field contacts to check logic and to ensure that actuators fail in the proper direction.
 - c. Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

3.15 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration. Prior to acceptance, perform the following performance tests to demonstrate system operation and compliance with specification after and in addition to tests specified in Article 3.15 (Control System Checkout and Testing). Provide Engineer with log documenting completion of startup tests.
1. Preliminary Review: At least 7 days prior to on-site demonstration, provide read-only username and password to Engineer for preliminary system review to be performed remotely. Engineer will review to verify all systems are connected and

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communicating and all points are reading properly, and graphics are complete. The Engineer will provide a report of any deficiencies. The contractor shall correct all deficiencies prior to on-site demonstration.

2. On-site Demonstration: Engineer, Owner, contractor(s) and any/all factory authorized equipment representatives shall be present to perform, observe and review system demonstration. Notify Engineer/Architect at least 10 days before system demonstration is scheduled.
 - a. Demonstration shall follow process submitted and approved under Section 23 09 23 Article 1.9 (Submittals). Complete approved checklists and forms for each system as part of system demonstration.
 - b. Demonstrate actual field operation of each sequence of operation as specified in Section 23 09 93. Provide at least two persons equipped with two-way communication. Demonstrate calibration and response of any input and output points requested by Engineer. Provide and operate test equipment required to prove proper system operation.
 - c. Demonstrate compliance with sequences of operation through each operational mode.
 - d. Demonstrate complete operation of operator interface.
 - e. Demonstrate each of the following.
 - f. DDC loop response. Supply graphical trend data output showing each DDC loop's response to a setpoint change representing an actuator position change of at least 25% of full range. Trend sampling rate shall be from 10 seconds to 3 minutes, depending on loop speed. Each sample's trend data shall show setpoint, actuator position, and controlled variable values. Engineer will require further tuning of each loop that displays unreasonably under- or over-damped control.
 - g. Demand limiting. Supply trend data output showing demand-limiting algorithm action. Trend data shall document action sampled each minute over at least a 30-minute period and shall show building kW, demand-limiting setpoint, and status of setpoints and other affected equipment parameters.
 - h. Building fire alarm system interface.
 - i. Trend logs for each system. Trend data shall indicate setpoints, operating points, valve positions, and other data as specified in the points list provided with each sequence of operation in Section 23 09 93. Each log shall cover three 48-hour periods and shall have a sample frequency not less than 10 minutes or as specified on its points list. Logs shall be accessible through system's operator interface and shall be retrievable for use in other software programs as specified in Section 23 09 23 Article 2.3 Paragraph F.11 (Trend Configuration).

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3. Tests that fail to demonstrate proper system operation shall be repeated after Contractor makes necessary repairs or revisions to hardware or software to successfully complete each test.
- B. Acceptance.
1. After tests described in this specification are performed to the satisfaction of both Engineer and Owner, Engineer will accept control system as meeting completion requirements. Engineer may exempt tests from completion requirements that cannot be performed due to circumstances beyond Contractor's control. Engineer will provide written statement of each exempted test. Exempted tests shall be performed as part of warranty.
 2. System shall not be accepted until completed demonstration forms and checklists are submitted and approved as required in Section 23 09 23 Article 1.9 (Submittals).

3.16 CLEANING

- A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
- B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.
- C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

END OF SECTION 23 09 23

SECTION 23 09 23.18 - CARBON MONOXIDE MONITORING SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract and the requirements of Section 15050 apply to the work specified in this Section.
- B. Gas detection system must meet or exceed Texas State Boiler Code 60.603-2015.
- C. ETL Listed to UL61010-1, CAN/CSA C22.2 No 61010-1, and LADBS Approved.
- D. Gas detection system must meet or exceed current OSHA and NIOSH alarm levels for personnel exposure to Carbon Monoxide.

1.2 SUBMITTALS

- A. **Provide line-by-line specification review annotated to certify compliance or deviation.**
- B. Submit in accordance with Division 1 and Section 23 05 00.
- C. Provide Monitor Panel as required to provide function in this specification and as shown on drawings.
- D. Provide panels with electrical characteristics shown on the electrical drawings.
- E. Carbon Monoxide system shall be third party validated to UL61010.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for operation, replacement parts, spare parts list, and wiring diagrams.

1.4 WARRANTY

- A. Furnish one (1) year manufacturer parts and labor warranty for complete monitoring system. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or startup will not be acceptable.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) year's experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Monitoring system shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals,

construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.

- D. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. International Gas Detectors Tocsin controller & detector range.
 - 2. Honeywell / Vulcain

2.2 CARBON MONOXIDE (CO) GAS DETECTION SYSTEM

- A. Provide a CO gas detection system designed to measure the level of escaping heating plant exhaust gases in multiple monitoring areas.
- B. Gas detection must consist of a control panel that must be mounted outside of the risk area to enable pre-entry warning of room status and provide remote reset capability for the system (only once gas concentrations have reduced below any alarm levels).
- C. Gas detection system must be capable of being expanded to include flammable gas detection (to cover the fuel gas leakage and ignition/explosion risk) and refrigeration detection to enable interconnection to co-located Chiller Plant Areas without any loss of monitoring or alarm performance.
- D. **Shall be calibrated every (18) eighteen months and a record of calibration shall be posted in a conspicuous place.**
- E. Gas detection system enclosures for controllers or detectors should be a minimum of NEMA 3S (IP54).
- F. The gas detection system should consist of a central controller interconnecting with field mounted gas detectors of Electrochemical Cell technology. Interconnection between controller and field devices should be through a 2-core addressable multi drop highway highways depending on detector numbers and locations relative to controller. Detectors being mounted to best cover risk area according to current manufacturers and industry advice.
 - 1. The gas detection system should be an addressable type interconnecting to all field devices on a 2-core screen mutli-drop highway. Controller should have a minimum of a single highway expandable to 32 gas detectors.
 - 2. Addressable highway should have polarity independent cores utilizing Sentinel+ addressable protocol enabling simple and quick install without need for core identifications. Addressable highway should have a capacity of 32 detectors.
 - 3. The gas detection system shall automatically and continuously monitor for CO over the range 0-100 ppm and compare concentrations to user-settable PPM limits per areas monitored for selected gas.

4. Gas detection system to be capable of zoning alarm areas to enable a co-located Chiller Plant Room to be incorporated into locally fitted Heating Plant Room systems but provide independent alarms.
5. The gas detection system shall be capable of being calibrated specifically for CO over the range 0-100 ppm to enable compliance to local and national codes.
6. The gas detection system shall be capable of interconnecting with and monitoring Electrochemical Cell technology with factory and field calibrated settings. Measurement range for CO will be 0-100ppm with an accuracy of +/-3% as a percentage of full scale in ambient temperature ranges of 32 to 122 degrees Fahrenheit and 5 percent to 90 percent ambient humidity (non-condensing).
7. The gas detection system controller shall have a minimum of:
 - a. Common 24VDC 100mA output common to any alarm.
 - b. Four (4) SPCO alarm contacts -three (3) are for alarm levels and one (1) for system fault.
 - c. Three (3) indicator lights:
 1. green "on" for normal operation
 2. red "on" for alarm
 3. yellow "on" for system fault
 - c. Modbus RS485 output for connection to external devices with full Modbus Map freely available for 3rd parties.
 - d. Alarm and fault log capability for. Minimum of 1000 points.
7. All configuration and monitoring parameters on the gas detection controller may be accessed one or two ways concurrently:
 - a. Via web enabled devices accessing controllers on-board Wi-Fi pages; access must be Password protected.
 - b. Via Wi-Fi dongle connected onto detector (allowing access to all devices on highway); access must be password protected.
8. Three alarm levels shall be provided indicating three (3) independent "alarm" level conditions. Thresholds for all alarms are to be individually adjustable with a factory setting of 20 PPM for "Alarm 1", 50 PPM for "Alarm 2", and 100 PPM for "Alarm 3". To minimize false alarms, the unit's minimum/maximum alarm levels should be set at factory recommended settings in compliance with relevant local and national codes.
8. System should be capable of operation even though a fault occurs. Controller should have a fault Indicator light and display should detail nature of the Fault.
9. The gas detection system should have an electronics warranty of minimum 10 years; sensor warranty for CO to be a minimum of 3 years.
10. Periodic gas detection system bump testing, calibration and checking or adjustments shall be capable of being accomplished by one person. Gas detection system shall have a self-diagnostics and indication of diagnostic status. Diagnostics shall include the CO sensor/s.
11. Installation of gas detection system should follow manufacturers installation recommendations (see IGD 2 Wire Installers Guide).

2.3 GAS DETECTION CONTROL PANEL

- A. Indoor control panels shall be fully enclosed NEMA 1 construction with hinged door key-lock latch and removable sub-panels. A common key shall open each control panel and sub-panel.
- B. The control panel should have an auto-setup function upon initiation. Upon first powering the device should ask for a FIND function that enables it to interrogate the connected highway, recognize and download details of all connected devices and automatically set channels and alarm points without any personnel interaction.
- C. The control panel provides remote programming, interrogation, and display functions to support the field mounted gas detectors. The system design supports compliance to the local and national codes.
- D. The control panel accepts a minimum of 1 Sentinel+ addressable input capable of monitoring up to thirty-two (32) field mounted detectors.
- E. Gas detector readings should be updated a minimum of once per second.
- F. Back lit LCD – The “Display” mode will display the measured point in PPM. The display will show a green backlight to reflect a safe condition and the light ring around the controller jog wheel will also be backlit green.
- G. The control panel should have the ability to log a minimum of 1000 events (alarms, resets, power activities etc.)
- H. Upon alarm, the channel display displays the channel in alarm (with live gas data), the backlit display changes from GREEN SAFE to RED , the light ring around the jog wheel changes from GREEN to RED, an internal 85dB sounder activates and the red alarm LED illuminates. Depending upon alarm Cause & Effect one or more of the SPCO, 230VAC 4Amp programmable relays change state.
- I. The LCD display indicates any input fault that may occur and identifies the fault area, upon FAULT the display will be backlit YELLOW, the light ring around the jog wheel changes from GREEN to YELLOW.
- J. The Control Panel shall provide Modbus RS485 to enable to operate in parallel with building management systems for the monitoring and interrogation of the control panel data.
- K. Control panel shall be able to “lock out” any instructions through the local keypad by password.
- L. Upon power failure, the control panel will have the capability to restart all individual monitors on the system. Upon return of electrical power, the control panel will be able to re-boot itself and return to operation without loss of programming or stored data (one month downtime without loss of data as a minimum).
- M. The control panel should be capable of operating devices up to 3000 feet from controller location dependent on cable core size and detector location.
- N. Two-way communication via Sentinel+ to a maximum of 32 detectors linked together in daisy-chain fashion is required. An onboard Wi-Fi port should enable password protected access by any web enabled device.
- O. The control panel shall have an operating temperature of 32° – 122°F.
- P. The control panel power consumption shall be less than 10 watts maximum 85-230VAC and be capable of running on 50 to 60 HZ power supply.
- Q. There shall be one common 24VDC output for local beacon sounders and four (4) relays in the monitor unit. Four (4) relays shall be available for customer connections. All relays shall be rated at 230VAC 4 AMP. Alarm relays shall be capable of being programmed within the

gas detection range and options to be Rising or Falling, Latched alarms or Auto-reset, energized or none energized configurations.

- a. ALARM 1: The Alarm relay connection shall be provided for the addition of an audible or visual warning device, fan activation or Plant shutdown. This relay will energize in the event that an area for Alarm 1 level has been exceeded.
 - b. ALARM 2: The Alarm relay connection shall be provided for the additional of fan activation or plant shutdown. This relay will "energize" in the event that an area for Alarm 2 level has been exceeded.
 - c. ALARM 3: The Alarm relay connection shall be provided for the additional of fan activation or plant shutdown. This relay will "energize" in the event that an area for Alarm 3 level has been exceeded.
 - d. FAULT: The Fault relay shall be a normally energized relay automatically changing state upon FAULT or Power Loss.
- O. Unit power consumption shall be less than 50 watts maximum, 230 volts AC and be capable of running on 60 Hz supply.
- P. Program access to be denied by password to prevent unauthorized personnel from accessing the device. Program will automatically reset to full function settings following power interruption.
- Q. Gas detection. Controller must be capable of operating additional flammable detectors (for fuel gas leak detection within Heating Plant Room and/or refrigerant detectors for Chiller Room.
- R. Gas detection system to be capable of zoning alarm areas to enable Chiller Plant Room systems to be incorporated into locally fitted Heating Plant Room systems but provide independent alarms.
- S. Wiring connections shall be through 20mm electrical ports located on the bottom panel of the enclosure. Rear of control panel should be capable of being rotated to enable cable ports to be placed top or bottom. Rear panel knock outs should also be provided for cable entries.

2.4 GAS DETECTORS

- A. The gas detectors shall be electrochemical cell technology with factory and capable of field calibration.
- B. Gas detectors must be provided pre-calibrated and be able to interact with the control panel during its initial FIND operation to automatically set up the details of gas type, range and alarm points.
- C. Gas detectors shall be 2 wire addressable technology compatible with Sentinel+ protocol and polarity independent connection.
- D. Gas detectors shall have inboard I/O to enable (as a minimum) a 24VDC beacon sounder to be connected locally (maximum rating 100mA). Beacon sounder functions to be split for independent beacon & sounder operation (muting etc.).
- E. Gas detectors to have an onboard Volt Free SPCO Relay rated 230VAC 4 Amp to enable local switching of plant (ventilation, heating plant de-activation, solenoid closure etc.).
- F. Gas detectors should have a "hot swappable" front that enables gas sensors to be exchanged at end of life, upgraded, or swapped to other technologies or gas types upon plant change requirements.

- G. Measurement range for CO with an accuracy of +/- 3% of full scale in ambient temperature ranges of 32 to 122 degrees Fahrenheit and 5 percent to 90 percent ambient humidity (non-condensing).
- H. The gas detection system shall adhere to a temperature drift tolerance of 0.3 percent per degrees Celsius and have a sensitivity of 1 PPM (parts per million).
- I. Gas monitoring should be continuous.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install panels and all detectors as shown on the drawings. Sufficient clearances allow easy service, maintenance, and replacement components.
- B. Controller should always be placed outside of the Plant Room to enable pre-entry warning to personnel of room status.
- C. Remote reset capability for the system should be at the controller and external of the Heating Plant Room.
- D. Provide a combination strobe light and horn inside plant room to enable an evacuation alarm to be provided. The audible alarm shall be heard over the background room noise. The strobe light shall be energized when there is an alarm.
- E. Installation of gas detection system should follow manufacturers installation recommendations (see IGD 2 Wire Installers Guide).
- F. Demonstrate all functions of CO gas detection system.
- G. Train the Owner on operations and maintenance of CO detection system.

3.2 SEQUENCE OF OPERATION

- A. Refer to Section 23 09 93 Sequence of Operations for HVAC Controls for detailed CO sequence of operation requirement.
- B. Carbon Monoxide detection system shall monitor the presence of CO in the Heating Plant Room. If CO is detected, a scaled automatic system of room evacuation and plant shutdown will be initiated linked to detected gas concentrations. The following sequence shall also be initiated from a manual switch located on the CO detection system panel. The CO system supplier shall provide a "dry" set of contacts, initiated automatically. On activation of the contacts, the following sequence shall occur.
 - 1. Exhaust fan (Refer to plans for tag) shall be energized to high speed (if in place).,
 - 2. Heating plant (refer to plans for tag) shall be de-energized to prevent further gas propagation.
 - 3. BAS to be informed of alarms.
 - 4. Provide an audible and visual alarm in the Heating Plant Room. Initiate the alarm and flash the light when the exposure limit is exceeded.
 - 5. Control sequence above shall be accomplished by hard wire interlocks.

3.3 DEMONSTRATION AND TRAINING

- A. Demonstrate system operations and verify specified performance. A functional test of the installed system shall be performed to demonstrate proper functioning of all interlocks and protective systems specified or otherwise required. This testing shall be conducted in the presence of the Owner's representative and the Engineer. The Contractor shall submit test procedure for approval by the Engineer prior to testing.

END OF SECTION 23 09 23.18

EQUIPMENT SHALL BID AS AN ALTERNATE

SECTION 23 09 93 - SEQUENCES OF OPERATION FOR HVAC CONTROLS

GENERAL:

The BAS contractor shall provide all points listed under "Equipment Control Points" as well as any points required to accomplish the sequences of operation listed below. BAS Contractor shall provide new thermographics and programming for each system (new and existing equipment) to accurately reflect configuration and operation. At the 11 month walk-thru, BAS contractor shall provide a DDC demonstration and re-verification of point-to-point control of all equipment points and sequences with Owner and Engineer; no exceptions. BAS contractor must perform site visits of each and every building prior to bid date and thoroughly investigate all existing HVAC equipment pertaining to infrastructure upgrade. BAS contractor shall take inventory of existing equipment in order to determine what is to be removed, replaced, or upgraded. Failure to do so will be at BAS subcontractor's cost and not the owner or engineer.

This specification Section 23 09 93 is an extension of Specification Section 23 09 23. All items mentioned in Section 23 09 23 shall be tied to this section and all BAS contractors bidding this Section are responsible for both specifications.

- BAS contractor shall schedule and participate in a pre-construction integration meeting with all vendors providing BACnet/Modbus or other equipment that is being integrated to the BAS. **Sample graphics shall be submitted for owner and engineer review. The meeting is a requirement and shall include but not limited to:**
 - Communications Requirements (MSTP/IP)
 - Points (Read/Write)
 - Connection Requirements (CAT5/6, 2-wire, 4-wire)
 - Coordinate Communication speeds when devices are MSTP.
 - Coordinate or Establish Device Instance Numbering System
 - Coordinate final points list(s) with owner/engineer
- Equipment provider must provide a certified controls start-up technician in order to assist with integration. This includes but is not limited to the following:
 - Inputting the device address, MAC address or IP address. (If equipment is to be BACnet/IP the equipment manufacturer shall be responsible for making sure the equipment points are pulled into customers network)
 - Ensuring appropriate points mapped and enabled. Assistance with pulling in points onsite is to be included for ALL equipment with on-board controls. Equipment controls technician is to be onsite with BAS Controls tech.
 - Equipment point read/write option selection as needed.
 - All points pulled into onboard controller are reading properly through on-board controller and through the BAS interface, with points matching.
 - BACnet Priority levels are not holding out commands from BAS.
 - The controls contractor is not responsible if there is a differentiation in how the on-board controls are programmed compared to the design SOO.
 - Remote technical assistance is not to be the BAS controls responsibility in order to troubleshoot and diagnose control through BACnet
- No portion of the total contract will be declared substantially complete until the graphics and automatic temperature control system has been demonstrated to be complete and functioning as intended. The BAS system will be complete and functioning as intended when all of the space temperatures are maintained at plus or minus two degrees of set point.

EQUIPMENT SHALL BID AS AN ALTERNATE

- BAS contractor shall provide and install all low voltage control wiring (with conduit if located outdoors or exposed below ceiling) for equipment such as but not limited to boilers, split systems, rooftop units, IDF/MDF units, unit heaters, dust collectors, welding equipment, etc. to facilitate communication between equipment.
- All BAS exposed control wiring below the ceiling and especially outdoors (rigid) shall be in conduit; furnished and installed by BAS subcontractor.
- All outside air dampers serving outside air handling units shall be stainless steel. Mount outside air dampers in lower elevation without the use of a ladder for accessibility. The controls contractor is responsible for providing dampers to be installed within duct for mechanical contractor to install.
- Equipment provider must provide a certified controls start-up technician in order to assist with integration. This includes but is not limited to the following:
 - Inputting the device address, MAC address or IP address. (If equipment is to be BACnet/IP the equipment manufacturer shall be responsible for making sure the equipment points are pulled into customers network)
 - Ensuring appropriate points mapped and enabled. Assistance with pulling in points onsite is to be included for ALL equipment with on-board controls. Equipment controls technician is to be onsite with BAS Controls tech.
 - Equipment point Read/write option selection as needed.
 - All points pulled into onboard controller are reading properly through on-board controller and through the BAS interface, with points matching.
 - BACnet Priority levels are not holding out commands from BAS.
 - The controls contractor is not responsible if there is a differentiation in how the on-board controls are programmed compared to the design SOO.
 - Remote technical assistance is not to be the BAS controls responsibility in order to troubleshoot and diagnose control through BACnet
- BAS shall BACnet interface to boilers, VFDs, utility meters, and equipment provided with on-board controls. Water and Gas meters to be provided by controls contractor. See schedule on mechanical plans.
- Any BACnet interfaced equipment must come with an onboard controller that is BTL listed. The BACnet controller must make all BACnet points available to the BMS.
- Equipment manufacturer for BACnet controlled equipment must provide onsite dedicated resources for the setup of the integration to BMS.
- Space Temperature Sensors shall be stainless steel flush plate type without adjustments or readings.
- HVAC shutdown button shall be yellow color push off-twist reset. In clear non-lockable cover labeled "HVAC Emergency Shutdown". Located behind Admin Secretaries Desk.

EQUIPMENT SHALL BID AS AN ALTERNATE

- Control panels to have laminated engraved nameplates with "as installed" control diagrams.
- NEMA 1 enclosures for indoor panels, NEMA 4 for outdoor panels. Continuous piano type hinged doors, key-lock latch and removable sub-panels.
- CO2 sensors in vandal proof vented lockable enclosures in high occupant/traffic areas (i.e. Gyms, Library, Auditorium, Hallways, etc.)

1. CHILLED WATER SYSTEM – PRIMARY / SECONDARY PUMPING

Two (2) equal sized water-cooled chillers with dedicated primary chilled water pumps and secondary chilled water pumps.

Equipment Control Points:

Plant CHW supply temperature – AI
Plant CHW return temperature – AI
Plant CHW flow – AI
Building CHW differential pressure - AI
Decouple Loop Temperature – AI
Decouple Loop Flow (Bi-directional flow meter) – AI
Chiller Amps/Status, each chiller -AI
Chiller CHW Supply Temperature, each chiller – AI
CW Return Temperature, each chiller – AI
Chiller Alarm, each chiller – DI
CHP Pump status, each pump - DI
SCHP pump status, each pump – DI
Chiller ISO Valves, 2 per chiller – DO
Chiller ISO Valves – End Switch / Feedback, 2 per chiller - DI
Chiller start/stop, each chiller – DO
SCHP pump start/stop, each pump – DO
CHP pump start/stop, each pump – DO
SCHP pump speed control – AO (each pump)
Chiller Reset, each chiller - AO

Chilled Water System Activation

The chilled water system shall be activated by a request for cooling from any unit it supplies with chilled water. The number of cooling requests required and the length of time the requests must be received before activating the plant shall be operator adjustable. The chilled water system shall be disabled if the outside air temperature is less than 45°F (operator adjustable).

Chiller Activation

When the chilled water system is activated, the BAS shall open the lead chiller ISO valve(s), and start the lead chilled water pump(s). Open the valves and allow 5 minutes (adjustable) prior to pump activation. A current switch shall prove status to the BAS control module and shall alarm at the central site if a switch is not made within 20 seconds (adjustable). When pump status has been proven for 1 minute (adjustable), the BAS shall start the lead chiller. When chilled water flow has been proven by flow switches, hardwire interlock and BAS input, the chiller shall start and maintain its leaving water temperature by its own internal controls. If the chiller fails to start within 2 minutes (adjustable), the BAS shall shut off its chilled water pumps and alarm the central site. If the chiller trips an internal alarm, it shall notify the BAS system through a set of normally closed contacts.

Chiller Sequencing

EQUIPMENT SHALL BID AS AN ALTERNATE

A current sensor at each chiller shall monitor the amperage of each chiller. The BAS shall also receive temperature inputs from sensors mounted in the secondary chilled water common supply and return piping. If the enabled chiller or chillers current load monitor indicates that the chiller or chillers are operating above 95% capacity and the building supply water temperature rises greater than 3°F (adjustable) above set point for five (5) minutes (adjustable) the next chiller in sequence shall be enabled into operation by the above-described sequence.

With more than one chiller operating, if the combined load decreases to 80% (adjustable) capacity of the previous state for ten (10) minutes (adjustable) and the building supply water temperature is less than 3°F (adjustable) above set point, a chiller shall be de-energized.

The equal size chillers shall be lead-lag alternated weekly by the BAS based upon cumulative runtime.

All the chillers shall run for a minimum of 10 minutes (adjustable) to prevent short cycling, and their chilled water pumps shall continue to run for an additional 5 minutes (adjustable) to insure adequate flow during shutdown.

Primary Chilled Water Loop Control

The primary loop is a constant volume system, a bypass line is provided for control and to assure constant flow through each chiller by accepting any deficit or surplus water from the secondary system. A flow meter capable of accurately measuring of flow in both directions ranging from full flow to 10% flow of one large chiller will be mounted in the bypass line. A temperature sensor will also monitor the bypass line temperature. The primary chilled water pumps shall pump a constant volume of water through the primary loop.

Provide new flow meter.

Secondary Chilled Water Pump Control

The secondary pumps shall be requested to run from the equipment being served. When the SCHP is commanded to run a current switch shall prove status to the BAS, which shall alarm at the central site if the switch is not made within 20 seconds (adjustable). If the lead pump indicates a bad status alarm the BAS shall discontinue the start signal to the lead SCHP and energize the lag SCHP to run. The lag SCHP now becomes the lead SCHP. The SCHP's shall be lead-lag alternated weekly at an operator adjustable time and day of the week by the BAS based upon accumulative runtime.

A differential pressure sensor across the building chilled water supply and return lines for secondary system (located 2/3 down longest pipe run) shall monitor building differential pressure across the mains. The BAS shall modulate the speed of the operating secondary chilled water pump to maintain the building chilled water differential pressure at setpoint (adjustable). If the lead SCHP is operating at greater than 90% (adjustable) and the building differential pressure is greater than 3 psi (adjustable) below setpoint for 5 minutes (adjustable) the lag SCHP shall be started in tandem with the lead pump. The lag pump shall run until both pumps are operating at less than 30 % (adjustable) for 5 minutes (adjustable) at which time the lag pump shall be disabled.

The BAS shall monitor the position of all of the chilled water valves of the units that each secondary pump set serves and the differential pressure setpoint shall be reset based on achieving a target valve position of 90%. There shall be a dead band of 5% to prevent hunting of the reset program. The chilled water flow shall not change by more than 10 percent per minute. The target valve position, the reset time, the dead band, and the rate of change values shall be operator adjustable. The secondary pumps shall be lead-lag and alternated weekly by the BAS based upon accumulative runtime.

Chilled Water Temperature Control

EQUIPMENT SHALL BID AS AN ALTERNATE

The BAS shall send a signal to the chiller reset to maintain the chiller controlling setpoint. The initial startup temperature shall be 42°F. If the plant is in state 1, and the building is in a low load condition, the BAS shall reset the chiller supply temperature up to a maximum of 48°F to optimize the chiller runtime. The temperature shall reset no more than 2°F every 15 minutes (adjustable).

A low load condition is defined when only one SCHWP is running at minimum speed, and the most open CHW valve (selectable) is less than 50% for 30 minutes (adjustable).

Freeze Protection

When the outdoor air temperature drops to 35°F (adjustable) or below, the BAS shall open the chilled water valves for flow through the coils for freeze protection and the primary and secondary chilled water pump system shall be activated to run until the low ambient temperature ceases to exist.

Chilled Water Decoupled Loop

When the chilled water system is active, decoupled loop flow and temperature will be monitored and trended by the plant manager. If the decoupled loop temperature is greater than chilled water supply by 10°F (adjustable), and the building supply temperature is greater than setpoint by 3°F (adjustable) for 30 minutes the plant shall increment to the next available state.

2. COOLING TOWER CONTROL (TWO CELLS)

Equipment Control Points:

Tower CW supply temperature - AI
Tower CW return temperature - AI
Tower Fan status, each fan – DI
Vibration alarm, each fan – DI
CW pump status, each pump - DI
Tower Fan start/stop, each fan – DO
Tower ISO valves, each tower (each tower inlet) – DO
Tower ISO valves – End Switch / Feedback, each tower (each tower inlet) – DI
CW pump start/stop, each pump – DO
Condenser water isolation valves – DO
Condenser water isolation valves – End Switch / Feedback – DI
Tower Fan speed, each fan - AO
CW Bypass Valve control, each tower – AO
CW Bypass Valve Control – End Switch / Feedback – AI

Cooling Tower Activation

When a tower is activated, the BAS shall open the corresponding isolation valves. The operator shall have the option of maintaining the lead towers ISO valves open at all times. The towers shall be lead-lag alternated weekly by the BAS based upon accumulative runtime.

Condenser Water Pump Activation

When the chilled water system has been requested, the lead chiller condenser water isolation valve shall be opened, and the lead condenser water pump shall be started. As additional chillers are enabled, additional condenser water pumps shall be started.

Automatic Backup

When a cooling tower fan or pump fails to start, the BAS shall automatically start the next tower or pump in the lead/lag sequence.

Condenser Water Temperature Control

EQUIPMENT SHALL BID AS AN ALTERNATE

The condenser water supply temperature shall be maintained by modulating the cooling tower bypass valve, staging on/off the tower fans, and modulating the tower fan speed on the active towers to maintain set point. The operator shall have the option of maintaining a fixed set point of 86°F (operator adjustable) or resetting the set point based on the outdoor air wet-bulb temperature. The reset set point shall be 6°F (adjustable) above the outdoor air wet-bulb temperature down to a minimum of 65°F (operator adjustable) and a maximum of 85°F (operator adjustable). If the condenser water supply temperature is below set point, the bypass valve shall be modulated open to the cooling tower basin. As the condenser water supply temperature rises, a PID control loop shall modulate the bypass valve closed forcing the water over the top of the active towers. If the condenser water temperature rises 2°F (adjustable) above set point, the B.A.S. shall start the lead cooling tower fan. A current switch shall prove status to the B.A.S. and shall alarm at the central site if the switch is not made within 20 seconds (adjustable). There shall also be a 5 second (adjustable) de-bounce time to prevent nuisance alarms from a bouncing switch. The B.A.S. shall monitor a vibration switch mounted at each tower; the B.A.S. shall cancel the run request to that tower, automatically enable the remaining tower and alarm the central site if the vibration switch detects a fault. The B.A.S. shall modulate the cooling tower fan speed from 20 Hz (adjustable) to 60 Hz (adjustable) to maintain the condenser water supply temperature at set point. If the condenser water temperature continues to rise and more than one tower is enabled the lag tower fan shall be energized and controlled in the above manner. Tower fans should modulate in unison.

3. COOLING TOWER MAKE-UP WATER

Equipment Control Points

Float Valve Low – DI (per Tower)

BAS will monitor the Float Valve (in each basin) and alarm central site upon Low Water level.

4. REFRIGERANT DETECTION MONITORING SYSTEM

Monitor general refrigerant level and leak alarm via interface. Chillers shall be hardwired interlock to shut down upon high level leak alarm.

Operation

A refrigerant detection system shall monitor the presence of refrigerant in the refrigeration machinery room. If refrigerant is detected, an automatic system of refrigerant evacuation will be initiated. The following sequence shall also be initiated from a manual switch located on the refrigerant detection system panel and a manual switch at each exit from machinery room. The refrigerant detection system shall be provided with a “dry” set of contacts, initiated automatically or manually. On activation of the contacts, the following sequence shall occur:

Exhaust fan EF-CP-01 shall be energized to high speed. EF-CP-01 normally operates on low speed to maintain negative pressure to adjacent occupied spaces. Makeup air louver motorized damper to open when exhaust fan EF-CP-01 is energized. BAS shall shutdown all pumps and chillers. Provide an audible and visual alarm in the machine room with a silence switch and pilot light. Initiate the alarm and flash the light when the exposure limit is exceeded. After the audible is reset the pilot light shall remain illuminated until the alarm clears.

Control sequence above shall be accomplished by hard wire interlocks. An alarm condition shall be annunciated at the BAS when the refrigerant leak detection panel determines exposure limits have been exceeded.

5. HEATING WATER SYSTEM

EQUIPMENT SHALL BID AS AN ALTERNATE

The heating water system is a hybrid boiler hot water system with primary / secondary pumps with multiple condensing boilers (refer to plans for quantity).

Equipment Control Points:

Building HW Supply Temperature – AI
Building HW Return Temperature – AI
Building HW Return Flow Meter – AI
Heating Water Supply Temperature – AI
Boiler Supply Temperature, each boiler – AI
Heating Water Differential Pressure – AI
Boiler Status, each boiler – DI
Boiler Alarm, each boiler – DI
Heating Water Pump Status, each pump – DI
CO Monitoring - DI
Boiler Enable, each boiler – DO
Heating Water Pump Start/Stop, each pump – DO
Heating Water Pump Speed Control, each pump – AO
Boiler Reset – AO

Heating Water System Activation

The heating water pump shall be activated by a request for heating from any equipment it supplies with heating water. A current switch shall prove status to the BAS and shall alarm at the central site if the contacts are not made within 20 seconds (adjustable). Once the heating water pump has proven positive flow, the BAS shall request the boiler system to run.

If the hot water supply temperature is less than 95°F (adjustable) or the building hot water pump status is not indicating the building hot water pump is running, the BAS control module shall broadcast that hot water is not available.

HW System is to include a stand-by pump which will be commanded on if the BAS commands the lead primary pump, and the pump status does not prove for more than 30 seconds (adjustable).
HW Pumps shall be rotated weekly to maintain equal runtime.

The BAS shall enable the system. The boiler sequencer decides who is lead and brings on the lag. The boiler controller also auto rotates if an alarm on the lead boiler is indicated.

Differential Pressure Control

A differential pressure sensor across the building heating water supply and return lines (located 2/3 down longest pipe run) shall monitor building differential pressure across the mains. The BAS shall modulate the speed of the lead heating water pump to maintain the building heating water differential pressure at setpoint (adjustable - final setpoint determined by TAB contractor).

The BAS shall monitor the position of all of the heating water valves and the differential pressure setpoint shall be reset based on achieving a target valve position of 90%. There shall be a dead band of 5% to prevent hunting of the reset program. The heating water flow shall not change by more than 10 percent per minute. The target valve position, the reset time, the dead band, and the rate of change values shall be operator adjustable.

Secondary HW Pumps shall be rotated weekly to maintain equal runtime.

Heating Water Temperature Reset: The heating water shall have a ratio

Reset based on outside air temperature and the following schedule:

EQUIPMENT SHALL BID AS AN ALTERNATE

Outside Air Temp	Less than 50°F	Hot Water Temp	180°F
Outside Air Temp	Greater than 70°F	Hot Water Temp	160°F

Carbon Monoxide Monitoring

A carbon monoxide sensor installed in the boiler room will alarm the BAS and shutdown the boiler. The BAS shall notify district maintenance personnel via e-mail and text message when the level of carbon monoxide rises above 100 ppm (adjustable). The sensor shall also alarm the BAS and shutdown the boiler upon loss of power to the sensor. A strobe light and audible alarm at the panel will be activated during an event. A pushbutton on the panel will silence the alarm and reset the system. Carbon monoxide sensor shall be calibrated every eighteen months and a record of calibration shall be posted in a conspicuous place.

Refer to specification section 23 09 23.18 for CO detection requirements.

Freeze Protection

When the outdoor air temperature drops to 34°F (adjustable) or below, the BAS shall open the hot water valves for flow through the coils for freeze protection. The hot water system shall be activated to run and the building HW supply set point shall be set to 100°F (adjustable) while running the boiler only until the low ambient temperature ceases to exist, or the building start-up time arrives.

6. SERIES FAN POWERED AIR TERMINAL UNIT (CVB) – WITH HOT WATER HEAT

Equipment Control Points

Space temperature – AI
Discharge temperature - AI
Cold deck flow – AI
Fan Start/stop – DO
Fan Status - AI
Cooling damper – AO
Re-heat valve – AO

Zone Occupancy

The parent AHU shall have an occupancy schedule assigned to it. Upon occupancy the AHU shall broadcast an occupancy signal to the terminal unit,

When the CVB Boxes calculated start, time arrives its internal fan motor shall be energized and continue to run until the unoccupied period arrives.

Temperature Control

When the zone becomes active, the CVB controller shall determine, based on the space temperature, whether heating or cooling is required. If cooling is required, the cooling air damper shall be modulated open to its operator adjustable maximum cooling CFM setpoint and cool request shall be sent to the air handling unit serving the CVB. As the space temperature returns to setpoint, the CVB cooling air damper shall modulate to its operator adjustable minimum cooling CFM setpoint.

The cooling damper actuator shall use a stepper motor so its position can be accurately tracked for display on the CVB graphic and collected by the air-handling unit serving the CVB to reset the air handling unit static pressure setpoint.

If heating is required, a run request will be sent to the heating water system (See Hot Water Sequence of Operation). The CVB terminal damper will be maintained at its adjustable minimum

EQUIPMENT SHALL BID AS AN ALTERNATE

heating CFM setpoint, and the hot water reheat valve will be modulated (0-10v) to maintain the space temperature.

Unoccupied Control

During the unoccupied time period, the CVB cooling damper shall be open (operator adjustable) and its fan shall be de-energized. If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F heating and 95°F cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints.

7. COOLING ONLY VAV TERMINAL BOX UNITS

Equipment Control Points

Space temperature – AI
Discharge temperature - AI
Cold deck flow - AI
Cooling damper – AO

Temperature Control

When the zone becomes active, the VAV controller shall determine based on the space temperature, if cooling is required. If cooling is required, the cooling air damper shall be modulated open to its maximum cooling CFM setpoint (adjustable) and a run request shall be sent to the air handling unit serving the VAV. As the space temperature returns to setpoint, the VAV cooling air damper shall modulate to its operator adjustable minimum cooling CFM setpoint (30% of maximum).

Zone Occupancy

Each parent VAV shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature versus the occupied heating or cooling setpoint, assigned recovery rate, and outdoor air temperature -- all variables are operator assignable from the central site. The VAV control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

8. SINGLE DUCT VARIABLE AIR VOLUME AIR HANDLING UNITS

AHU-B1{classrooms}, AHU-E1 {classrooms}, AHU-B2 {classrooms}, AHU-A1 {classrooms}, AHU-B3 {classrooms}, AHU-F1 {classrooms}, AHU-E2 {classrooms}}

Equipment Control Points

Supply Air Temperature – AI
Discharge CHW coil Temperature – AI
Discharge Preheat HW coil Temperature – AI
Supply Air Static Pressure – AI
Fan Status – DI
Filter Status – DI
Static Pressure High Limit – DI
Freeze Stat – DI
Fan Speed Control – AO
Chilled Water Valve Control – AO
Air Handling Unit Fan Start/Stop – DO
Hot Water Preheat Water Valve Control – AO
Exhaust Fan Start/Stop – DO
Outdoor Air Damper – DO
Damper End Switch – DI

EQUIPMENT SHALL BID AS AN ALTERNATE

AHU Activation

Each air handler shall have an occupancy/vacancy schedule. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature versus the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site.

Fan Control

When the air handler is requested to run, the B.A.S. control module will send signal to the air handler inverter, which will energize the fan. A current switch will prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There will also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request will be sent to the Chilled Water System when the air-handling unit is active, and cooling is required.

Temperature Control

When the air handling unit is in occupied mode and cooling is required, the BAS shall send a request for cooling to the chiller plant and shall modulate the chilled water control valve to maintain leaving air temperature setpoint (55 °F, adjustable). The BAS shall have the ability to reset the leaving air temperature based on cooling request. When there are no cooling requests, the leaving air temperature setpoint shall reset up to a maximum of 58 °F (adjustable). When 2 (adjustable) or more cooling requests are present, the leaving air temperature setpoint shall reset down to 52 °F (adjustable). The reset shall not exceed more than 0.2 °F (adjustable) every 3 minutes (adjustable).

When the outdoor air handling unit is active, and heating is required a duct temperature sensor mounted downstream of the pre-heat coil will modulate the pre-heat valve to maintain the operator adjustable pre-heat discharge air temperature set point of 55°F (adjustable).

Air Volume Control

While the air handling unit is active, the BAS shall maintain the duct static pressure setpoint at 1.5" w.g. (adjustable, final setpoint to be determined by TAB contractor) by modulating the speed of the supply fan through a variable speed drive (VSD). A static pressure sensor mounted two-thirds down the longest duct run shall monitor the duct static pressure. A manual-reset static pressure high limit switch shall monitor the static pressure of the supply duct. If the duct static pressure rises above 3.0" w.g. (locally adjustable) the air handling unit shall be de-energized via hard-wire interlock to the VFD safety circuit. The BAS shall monitor the high static limit switch and shall display an alarm at the central site. The static pressure high limit switch must be manually reset.

The static pressure shall reset to achieve a target damper setpoint of 85% with a 5% dead-band. Static pressure shall reset by not more than 0.2" W.C. every 3 minutes. Static pressure shall be a minimum of 0.5" W.C.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersedes the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

EQUIPMENT SHALL BID AS AN ALTERNATE

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

9. SINGLE DUCT VARIABLE AIR VOLUME AIR HANDLING UNITS WITH DX COIL [AHU-C1{admin}]

Equipment Control Points

Supply Air Temperature – AI
Discharge CHW coil Temperature – AI
Discharge Preheat HW coil Temperature – AI
DX Cooling Coil Discharge Air Temperature – AI
Supply Air Static Pressure – AI
Fan Status – DI
Filter Status – DI
Static Pressure High Limit – DI
Freeze Stat – DI
Fan Speed Control – AO
Chilled Water Valve Control – AO
Air Handling Unit Fan Start/Stop – DO
DX Cooling Stages - DO (quantity to match AHU)
Hot Water Preheat Water Valve Control – AO
Exhaust Fan Start/Stop – DO
Outdoor Air Damper – DO
Outdoor Air Damper End Switch – DI
Return Air Damper – DO
Return Air Damper End Switch – DI

AHU Activation

Each air handler shall have an occupancy/vacancy schedule. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature versus the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site.

Fan Control

EQUIPMENT SHALL BID AS AN ALTERNATE

When the air handler is requested to run, the B.A.S. control module will send signal to the air handler inverter, which will energize the fan. A current switch will prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There will also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request will be sent to the Chilled Water System when the air-handling unit is active, and cooling is required.

Temperature Control

When the air handling unit is in occupied mode and cooling is required, the BAS shall send a request for cooling to the chiller plant and shall modulate the chilled water control valve to maintain leaving air temperature setpoint (55 °F, adjustable). The BAS shall have the ability to reset the leaving air temperature based on cooling request. When there are no cooling requests, the leaving air temperature setpoint shall reset up to a maximum of 58 °F (adjustable). When 2 (adjustable) or more cooling requests are present, the leaving air temperature setpoint shall reset down to 52 °F (adjustable). The reset shall not exceed more than 0.2 °F (adjustable) every 3 minutes (adjustable).

When the outdoor air handling unit is active, and heating is required a duct temperature sensor mounted downstream of the pre-heat coil will modulate the pre-heat valve to maintain the operator adjustable pre-heat discharge air temperature set point of 55°F (adjustable).

Air Volume Control

While the air handling unit is active, the BAS shall maintain the duct static pressure setpoint at 1.5" w.g. (adjustable, final setpoint to be determined by TAB contractor) by modulating the speed of the supply fan through a variable speed drive (VSD). A static pressure sensor mounted two-thirds down the longest duct run shall monitor the duct static pressure. A manual-reset static pressure high limit switch shall monitor the static pressure of the supply duct. If the duct static pressure rises above 3.0" w.g. (locally adjustable) the air handling unit shall be de-energized via hard-wire interlock to the VFD safety circuit. The BAS shall monitor the high static limit switch and shall display an alarm at the central site. The static pressure high limit switch must be manually reset.

The static pressure shall reset to achieve a target damper setpoint of 85% with a 5% dead-band. Static pressure shall reset by not more than 0.2" W.C. every 3 minutes. Static pressure shall be a minimum of 0.5" W.C.

Outside air damper and return air damper shall be interlocked with the unit to open and close when unit is energized and de-energized.

After Hours Cooling

The air handling unit is furnished with a Hydronic Cooling coil and in addition a Direct Expansion (DX) coil with matching air-cooled condensing unit. When the system is operating after hours, the BAS shall utilize the DX cooling for supply air temperature control and shall not send a request to the chiller plant.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersedes the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

EQUIPMENT SHALL BID AS AN ALTERNATE

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

10. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL, DCV & DX COIL [AHU-3 {auditorium}, AHU-4 {auditorium} & AHU-C3 {library}]

Equipment Control Points

Space Sensors – AI (Combo Temp, Humidity & CO₂, without display)

Discharge Air Temperature – AI

Cooling Coil Discharge Air Temperature – AI

DX Cooling Coil Discharge Air Temperature – AI

Reheat HW Coil Discharge Air Temperature – AI

Pre-Cooling Coil Discharge Air Temperature – AI

Pre-heat HW Coil Discharge Air Temperature – AI

CO₂ Level(s) – AI (refer to plans for quantities and locations)

Fan Status – DI

Filter Status – DI

Freeze Stat – DI

Air Handling Unit Fan Start/Stop – DO

Exhaust Fan Start/Stop – DO

DX Cooling Stages - DO (quantity to match AHU)

Fan Speed Control – AO

Chilled Water Valve Control – AO

Re-Heat Water Valve Control – AO

Pre-Cooling Water Valve Control – AO

Pre-Heat Water Valve Control - AO

OA Damper Control – AO

OA Damper End Switch – DI

RA Damper Control (AHU-C3) – AO

RA Damper End Switch (AHU-C3) – DI

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses

EQUIPMENT SHALL BID AS AN ALTERNATE

the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control – Main Cooling and Re-Heat Coil

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control – Pre-Cooling & Pre-Heating Coil

When the air handling unit is active, and heating is required a duct temperature sensor mounted downstream of the pre-heat coil will modulate the pre-heat valve to maintain the operator adjustable pre-heat discharge air temperature set point of 55°F (adjustable). If cooling is required a duct temperature sensor mounted downstream of the pre-cooling coil modulates the chilled water valve to maintain the operator adjustable discharge air temperature set point of 55°F (adjustable).

Outside Air Control (Demand Control Ventilation)

When the air handler is running in the occupied mode, the O.A. damper control shall be enabled. A CO₂ sensor mounted in various spaces as indicated on drawings, shall monitor the CO₂ level (see series fan powered box sequence). The B.A.S. shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO₂ level between 850 ppm and 1,000 ppm (all adjustable). If the CO₂ level rises above 1,200 ppm an alarm shall be sent to the central site. OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM. The B.A.S. shall select the highest level when more than one CO₂ sensor is used to modulate the damper.

The outside air damper shall remain closed during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

AHU-C3: The BAS shall modulate the motorized outside air and return damper in unison to maintain supply air required.

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises

EQUIPMENT SHALL BID AS AN ALTERNATE

above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

After Hours Cooling

The air handling unit is furnished with a Hydronic Cooling coil and in addition a Direct Expansion (DX) coil with matching air-cooled condensing unit. When the system is operating after hours, the BAS shall utilize the DX cooling for supply air temperature control and shall not send a request to the chiller plant.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

11. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL, DCV & DX COIL [AHU-5 band hall]

Equipment Control Points

Space Sensors – AI (Combo Temp, Humidity & CO₂, without display)
Discharge Air Temperature – AI
Cooling Coil Discharge Air Temperature – AI
DX Cooling Coil Discharge Air Temperature – AI
Reheat HW Coil Discharge Air Temperature – AI

EQUIPMENT SHALL BID AS AN ALTERNATE

CO2 Level(s) – AI (refer to plans for quantities and locations)
Fan Status – DI
Filter Status – DI
Freeze Stat – DI
Air Handling Unit Fan Start/Stop – DO
Exhaust Fan Start/Stop – DO
DX Cooling Stages - DO (quantity to match AHU)
Fan Speed Control – AO
Chilled Water Valve Control – AO
Re-Heat Water Valve Control – AO
OA Damper Control – AO
OA Damper End Switch – DI
RA Damper Control – AO
RA Damper End Switch – DI

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Outside Air Control (Demand Control Ventilation)

When the air handler is running in the occupied mode, the O.A. damper control shall be enabled. A CO₂ sensor mounted in various spaces as indicated on drawings, shall monitor the CO₂ level (see series fan powered box sequence). The B.A.S. shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO₂ level between 850 ppm and 1,000 ppm (all adjustable). If the CO₂ level rises above 1,200 ppm an alarm shall be sent to the central site. OA dampers minimum and maximum positions shall be determined by the T.A.B.

EQUIPMENT SHALL BID AS AN ALTERNATE

contractor to be the positions that allow the scheduled minimum and maximum OA CFM. The B.A.S. shall select the highest level when more than one CO₂ sensor is used to modulate the damper.

The outside air damper shall remain closed during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

Return air damper shall be interlocked with the unit to open and close when unit is energized and de-energized.

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

After Hours Cooling

The air handling unit is furnished with a Hydronic Cooling coil and in addition a Direct Expansion (DX) coil with matching air-cooled condensing unit. When the system is operating after hours, the BAS shall utilize the DX cooling for supply air temperature control and shall not send a request to the chiller plant.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

EQUIPMENT SHALL BID AS AN ALTERNATE

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

12. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL & DCV
[AHU-11 {cafeteria}]

Equipment Control Points

Space Sensors – AI (Combo Temp, Humidity & CO₂, without display)
Discharge Air Temperature – AI
Cooling Coil Discharge Air Temperature – AI
Reheat HW Coil Discharge Air Temperature – AI
CO₂ Level(s) – AI (refer to plans for quantities and locations)
Fan Status – DI
Filter Status – DI
Freeze Stat – DI
Air Handling Unit Fan Start/Stop – DO
Exhaust Fan Start/Stop – DO
Fan Speed Control – AO
Chilled Water Valve Control – AO
Re-Heat Water Valve Control – AO
OA Damper Control – AO
Damper End Switch – DI
UV Light – DO

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating

EQUIPMENT SHALL BID AS AN ALTERNATE

setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Outside Air Control (Demand Control Ventilation)

When the air handler is running in the occupied mode, the O.A. damper control shall be enabled. A CO₂ sensor mounted in various spaces as indicated on drawings, shall monitor the CO₂ level (see series fan powered box sequence). The B.A.S. shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO₂ level between 850 ppm and 1,000 ppm (all adjustable). If the CO₂ level rises above 1,200 ppm an alarm shall be sent to the central site. OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM. The B.A.S. shall select the highest level when more than one CO₂ sensor is used to modulate the damper.

The outside air damper shall remain closed during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted upstream of the cooling coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

EQUIPMENT SHALL BID AS AN ALTERNATE

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

The UV light shall have an occupancy/vacancy schedule similar to the associated AHU. UV light shall not turn on during unoccupied mode.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

13. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL

[AHU-08 {lockers}, AHU-09 {choral room}, AHU-10 {music ensemble}, AHU-9 {gym} & AHU-10 {gym}]

Equipment Control Points

Space Sensors – AI (Combo Temp & Humidity, without display)
Discharge Air Temperature – AI
Cooling Coil Discharge Air Temperature – AI
Reheat HW Coil Discharge Air Temperature – AI
Fan Status – DI
Filter Status – DI
Freeze Stat – DI
Air Handling Unit Fan Start/Stop – DO
Exhaust Fan Start/Stop – DO
Fan Speed Control – AO
Chilled Water Valve Control – AO
Re-Heat Water Valve Control – AO
OA Damper Control – AO
Damper End Switch – DI
UV Light (AHU-08, AHU-9 gym & AHU-10 gym) – DO

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

EQUIPMENT SHALL BID AS AN ALTERNATE

Temperature Control

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted upstream of the cooling coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

AHU-08, AHU-9 gym & AHU-10 gym: The UV light shall have an occupancy/vacancy schedule similar to the associated AHU. UV light shall not turn on during unoccupied mode.

EQUIPMENT SHALL BID AS AN ALTERNATE

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

**14. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL & AFMS
[AHU-D1 {lockers}]**

Equipment Control Points

Space Sensors – AI (Combo Temp & Humidity, without display)

Discharge Air Temperature – AI

Cooling Coil Discharge Air Temperature – AI

Reheat HW Coil Discharge Air Temperature – AI

Airflow Measuring Station – AI

Fan Status – DI

Filter Status – DI

Freeze Stat – DI

Air Handling Unit Fan Start/Stop – DO

Exhaust Fan Start/Stop – DO

Fan Speed Control – AO

Chilled Water Valve Control – AO

Re-Heat Water Valve Control – AO

OA Damper Control – AO

OA Damper End Switch – DI

RA Damper Control – AO

RA Damper End Switch – DI

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating

EQUIPMENT SHALL BID AS AN ALTERNATE

setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

Outside Air Control

When the unit is in occupied mode, the BAS controller shall open the outside air damper.

The outside airflow shall be measured by the flow measuring station and reported to the BAS. The BAS shall modulate the motorized outside air and return damper in unison to maintain constant volume outside air and supply air as scheduled.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted upstream of the cooling coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

EQUIPMENT SHALL BID AS AN ALTERNATE

15. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL **[AHU-C2 {kitchen}]**

Equipment Control Points

Space Sensors – AI (Combo Temp & Humidity, without display)
Discharge Air Temperature – AI
Cooling Coil Discharge Air Temperature – AI
Reheat HW Coil Discharge Air Temperature – AI
Pre-Cooling Coil Discharge Air Temperature – AI
Pre-heat HW Coil Discharge Air Temperature – AI
Fan Status – DI
Filter Status – DI
Freeze Stat – DI
Air Handling Unit Fan Start/Stop – DO
Exhaust Fan Start/Stop – DO
Fan Speed Control – AO
Chilled Water Valve Control – AO
Re-Heat Water Valve Control – AO
Pre-Cooling Water Valve Control – AO
Pre-Heat Water Valve Control - AO
OA Damper Control – AO
Damper End Switch – DI

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control – Main Cooling and Re-Heat Coil

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

EQUIPMENT SHALL BID AS AN ALTERNATE

Temperature Control – Pre-Cooling & Pre-Heating Coil

When the air handling unit is active, and heating is required a duct temperature sensor mounted downstream of the pre-heat coil will modulate the pre-heat valve to maintain the operator adjustable pre-heat discharge air temperature set point of 55°F (adjustable). If cooling is required a duct temperature sensor mounted downstream of the pre-cooling coil modulates the chilled water valve to maintain the operator adjustable discharge air temperature set point of 55°F (adjustable).

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

16. SINGLE ZONE VAV AIR HANDLING UNITS WITH HUMIDITY CONTROL & DCV [AHU-7 {aux. gym}]

Equipment Control Points

EQUIPMENT SHALL BID AS AN ALTERNATE

Space Sensors – AI (Combo Temp, Humidity & CO₂ without display)
Discharge Air Temperature – AI
Cooling Coil Discharge Air Temperature – AI
Reheat HW Coil Discharge Air Temperature – AI
Pre-Cooling Coil Discharge Air Temperature – AI
Pre-heat HW Coil Discharge Air Temperature – AI
CO₂ Level(s) – AI (refer to plans for quantities and locations)
Fan Status – DI
Filter Status – DI
Freeze Stat – DI
Air Handling Unit Fan Start/Stop – DO
Exhaust Fan Start/Stop – DO
Fan Speed Control – AO
Chilled Water Valve Control – AO
Re-Heat Water Valve Control – AO
Pre-Cooling Water Valve Control – AO
Pre-Heat Water Valve Control - AO
OA Damper Control – AO
Damper End Switch – DI

AHU Activation

The air-handling unit shall have an occupancy/vacancy schedule, occupied heating/cooling setpoints and unoccupied heating/cooling setpoints assigned to it. As the occupancy time approaches, an optimum start/stop program shall calculate a start time based on current space temperature verses the occupied heating or cooling setpoint, assigned recovery rate, and outside air temperature -- all variables are operator assignable from the central site. The air-handling unit control program shall have the ability to learn its recovery rate whenever the operator enables the learning feature.

Fan Control

When the air handler is requested to run, the B.A.S. control module shall send an enable signal to the air handler inverter, which will energize the fan. A current switch shall prove status to the Building Automation System (BAS) and alarm the central site if the switch is not made within 20 seconds (operator adjustable). There shall also be a 10 second (operator adjustable) de-bounce time to prevent nuisance alarms. A run request shall be sent to the Chilled Water System when the air-handling unit is active, and cooling is required. A run request shall be sent to the Heating Water System when the air-handling unit is active, and heating is required. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control – Main Cooling and Re-Heat Coil

A wall mounted space temperature sensor shall monitor the air temperature in the space. The B.A.S. shall output separate signals to modulate the chilled water and heating water control valve actuators in sequence to maintain the space temperature within its operator adjustable heating and cooling setpoints. As the zone temperature rises, the fan will modulate from its minimum speed (determined by the TAB contractor) to its maximum speed. As the zone temperature falls below the heating setpoint the fan will run at a fixed speed (determined by the TAB contractor) and the hot water valve will modulate to maintain the space heating temperature setpoint.

Temperature Control – Pre-Cooling & Pre-Heating Coil

When the air handling unit is active, and heating is required a duct temperature sensor mounted downstream of the pre-heat coil will modulate the pre-heat valve to maintain the operator adjustable

EQUIPMENT SHALL BID AS AN ALTERNATE

pre-heat discharge air temperature set point of 55°F (adjustable). If cooling is required a duct temperature sensor mounted downstream of the pre-cooling coil modulates the chilled water valve to maintain the operator adjustable discharge air temperature set point of 55°F (adjustable).

Space Humidity Control

A space humidity sensor, monitored by the B.A.S., shall set the cooling coil discharge air setpoint to 55°F (adjustable) and modulate the chilled water valve to maintain the setpoint if the humidity rises above 60% (adjustable) and continue until it falls by 5% (adjustable). The B.A.S. shall modulate the hot water reheat valve to maintain the space temperature between its heating and cooling setpoints. If the B.A.S. control module receives a broadcast from the HW system that heating water is not available (see Heating Water System sequence of operations) the chilled water valve shall not be overridden until heating water is available. The fan will run at a fixed speed while in dehumidification mode.

Outside Air Control (Demand Control Ventilation)

When the air handler is running in the occupied mode, the O.A. damper control shall be enabled. A CO₂ sensor mounted in various spaces as indicated on drawings, shall monitor the CO₂ level (see series fan powered box sequence). The B.A.S. shall modulate the outdoor air damper from its minimum position to its maximum position as required to maintain the CO₂ level between 850 ppm and 1,000 ppm (all adjustable). If the CO₂ level rises above 1,200 ppm an alarm shall be sent to the central site. OA dampers minimum and maximum positions shall be determined by the T.A.B. contractor to be the positions that allow the scheduled minimum and maximum OA CFM. The B.A.S. shall select the highest level when more than one CO₂ sensor is used to modulate the damper.

The outside air damper shall remain closed during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

Unoccupied Control

If the space temperature reaches the operator adjustable unoccupied setpoints of 55°F (adjustable) heating and 95°F (adjustable) cooling, the required equipment shall be started and run to maintain the space temperature within the setpoints. All values are operator adjustable.

If the space humidity reaches the operator adjustable unoccupied setpoints of 60% (adjustable), the required equipment shall be started and run to maintain the space humidity within the setpoints. All values are operator adjustable. Humidity setpoints supersede the temperature setpoints. The BAS shall initiate an alarm if temperature or humidity rises above unoccupied setpoint.

Freeze Protection

A manual reset low-limit temperature switch shall be mounted downstream of the pre-heating coil. The normally closed contacts of the switch shall be wired in series with the VSD safety interlock circuit so that, when activated, the VSD will shut down the fan. Upon sensing a low limit condition, the BAS shall open the HW and CHW control valves, close the outdoor air damper, energize the hot water & secondary chilled water pumps and boiler (see heating water sequence of operation), and alarm at the central site if the leaving air temperature drops to 34°F (locally adjustable). The freeze stat must be manually reset once the temperature rises above the trip point.

Associated Equipment

During the occupied time period, the outside air damper shall be open and/or a request to run shall be sent to the corresponding exhaust fans. The outside air dampers shall remain closed & exhaust fans shall remain off, even during a scheduled occupancy time based on a global command from a shelter in place (building shutdown) button activation or based on a summer mode schedule.

EQUIPMENT SHALL BID AS AN ALTERNATE

An airflow switch shall monitor the pressure across the air filter. A contact closure from the air filter switch will alarm and notify maintenance through the B.A.S. of a dirty filter.

Equipment OFF Conditions

When the air handling unit is de-energized, all the valves shall be closed, the outside air damper shall be closed, and any associated exhaust fans shall be de-energized.

17. KITCHEN HOOD EXHAUST FANS / PACKAGED, 100% OUTDOOR, HEATING ONLY SUPPLY FAN

Equipment Control Points

Exhaust/Supply Fans status (each fan) - Current switch – DI
Exhaust/Supply Fans enable – DO
Exhaust/Supply Fans Start/Stop – DO
Supply Fan Air Temperature – AI
Heating Coil Discharge Air Temperature – AI
Re-Heat Water Valve Control – AO
OA Damper Control – Supply Fan – AO
Damper End Switch - Supply Fan – DI
Hood Status – DI

The kitchen hood supply and exhaust fans shall be interlocked to operate together. The hood fans shall be enabled to run by the BAS based on an operator assigned schedule. When the fans are enabled to run, they shall be controlled via a local switch mounted at the hood. Status of each hood will be monitored by the BAS. If exhaust hood is switched on, its associated exhaust fan shall turn on and supply fan damper shall open. Once open as determined by end-switch, the supply fan will be enabled. The hot water valve shall modulate to maintain a supply air temperature of 75°F (adjustable). All fans shall remain off even during the scheduled operating time, based on a global command from a shelter in place (building shutdown) button or based on a summer mode schedule.

18. GENERAL EXHAUST

Equipment Control Points

Exhaust fan status – Current switch - DI
Exhaust fan enable – DO (interlocked to damper)

Interlock all general exhaust fans to run with outside air handling equipment serving the same area and run only during the occupied mode with their OA Dampers open. The EF shall be provided with OA dampers built into the curb adapter and shall be powered and operate from same circuit powering the fans. Dampers and actuators to be provided by the EF manufacture. The exhaust fans shall remain off even during the scheduled occupancy time based on a global command from a shelter in place (building shutdown) button or based on a summer mode schedule.

19. IN-LINE EXHAUST FANS – ELECTRICAL & IDF ROOMS

Equipment Control Points

Space temperature - AI
Fan status – DI
Fan start/stop - DO

The BAS shall start/stop the exhaust fans to maintain a space temperature of 80°F (adjustable) during occupied and unoccupied modes. The BAS shall monitor status of each fan. In addition to an exhaust fan, each Electrical Room shall have a dedicated cooling only variable air volume box which

EQUIPMENT SHALL BID AS AN ALTERNATE

shall modulate the air valve to maintain a space temperature of 74°F (adjustable) during occupied mode. The exhaust fan and VAV box shall have a common temperature sensor. The exhaust fan shall energize only in the event of the space temperature rising above room cooling setpoint during occupied mode and during unoccupied mode for 24 hour control capability.

20. DISHWASHER EXHAUST

Equipment Control Points

Exhaust/Supply Fan Status (each fan) - Current switch – DI

Interlock exhaust fan to operate when dishwasher is operating. Provide off delay to allow fan to run for 10 minutes (field adjustable) after dishwasher has been de-energized.

21. FREEZER/COOLER TEMPERATURE MONITORING AND ALARM

Equipment Control Points

Cooler temperatures – AI

Freezer temperatures – AI

The BAS contractor shall provide temperature sensors in the freezers and coolers. The BAS shall monitor the freezer and cooler temperatures and indicate the temperatures at the operator station. The BAS shall initiate an alarm if temperature rises above design and be sent to the computers, pagers, text message / compatible cell phone designated by district personnel. The BAS contractor shall set up trending information and reports per district standard. Coordinate with freezer/cooler manufacturer.

22. LOUVER – MOTORIZED DAMPERS

Equipment Control Points

Damper open/close – DO

Damper shall be interlocked with the associated unit. When the associated unit is energized / de-energized, the BAS controller shall open / close damper. Replace existing damper and actuator with new.

23. OUTSIDE AIR INTAKE HOODS

Equipment Control Points

Damper open/close – DO

When the associated Air Handling Unit is in occupied mode, the BAS controller shall open the outside air damper. Replace existing damper and actuator with new.

24. EMERGENCY BUILDING SHUTDOWN (SHELTER IN PLACE)

Equipment Control Points

Shutdown Switch Status – dry contact – DI

Provide a single mushroom style pushbutton adjacent to fire alarm control panel. Operation shall be pushbutton off, keyed switch on. Provide clear plastic cover to prevent accidental activation. Provide engraved identification tag with "Emergency HVAC Shutdown". When activated, the BAS shall shut down the HVAC system and close all intake, exhaust, and relief dampers. The button must be

EQUIPMENT SHALL BID AS AN ALTERNATE

manually reset (via key) to allow the HVAC system to resume normal operation. Confirm location with owner/architect prior to installation.

25. DUCTLESS MINI-SPLIT-SYSTEM AIR CONDITIONERS - IDF/MDF ROOMS

The split systems shall have a factory furnished controller and operate stand-alone based on unit thermostat. The BAS shall monitor the space temp only. Thermostat provided by unit manufacturer and installed by BAS.

Equipment Control Points

Space Temperature – AI (monitoring only)

26. OUTDOOR AIR CONDITIONS

Equipment Control Points

Outdoor air temperature – AI

Outdoor air humidity – AI

The new sensors shall be mounted in an area on the north side of the building where the representative temperature and humidity can be monitored, both shall have sun shields. Based on the outside air temperature and humidity the BAS shall calculate the outdoor enthalpy, wet bulb, and dew point temperatures. The outdoor air temperature and humidity shall be broadcast as global information for use by the other control programs.

27. EMERGENCY SHUTDOWN (SHELTER IN PLACE)

Equipment Control Points

Shutdown switch status – dry contact – DI

Provide a single mushroom style pushbutton adjacent to fire alarm control panel. Operation shall be pushbutton off, keyed switch on. Provide clear plastic cover to prevent accidental activation. Provide engraved identification tag with "Emergency HVAC Shutdown". When activated, the BAS shall shut down the HVAC system and close all intake, exhaust, and relief dampers. The button must be manually reset (via key) to allow the HVAC system to resume normal operation. Confirm location with owner prior to installation.

28. HVAC TIMED LOCAL OVERRIDE (TLO)

Equipment Control Points

Override button input – DI

A local override button located as directed by the owner shall allow temporary override of the admin system. Each press of the button shall place the system in occupied mode for 30 minutes (adjustable), to a maximum of 2 hours (adjustable).

29. COOL-DOWN CONTROL

ON-OFF: Prior to the start of the occupied mode, all air handling units shall be started and be controlled as specified except that the outside air units and associated air dampers shall remain closed, and the exhaust fans shall be OFF. The duration of the cool-down cycle shall be regulated by the BAS optimum start/stop routine. The cool-down cycle shall continue until all space temperatures are at or below the setpoint. Cool-down cycle shall not be initiated when outside air temperature is less than 80°F.

EQUIPMENT SHALL BID AS AN ALTERNATE

30. WARM-UP CONTROL

ON-OFF: Prior to the start of the occupied mode, all air handling units shall be started and be controlled as specified except that the outside air dampers shall remain closed, and the exhaust fans shall be OFF. The duration of the warm-up cycle shall be regulated by the BAS optimum start/stop routine. The warm-up cycle shall continue until all space temperatures are at or above the setpoint. Warm-up cycle shall not be initiated when outside air temperature is greater than 70°F.

31. EXTERIOR LIGHTING CONTROL

Equipment Control Points

Lighting contactor enable/disable - DO
Photocell - DI

The BAS contractor shall provide separate outputs for each contactor indicated on the electrical drawings. Each contactor shall be able to be controlled via operator defined schedule independently or in groups defined by the operator. Provide a photocell for monitoring by the BAS. Exterior lighting shall be turned off if the photocell senses light levels above a pre-determined limit.

Contractor shall program to allow the operator to select whether the system utilizes a boundary schedule and sunrise/sunset calculations. If the exterior lights are scheduled to operate, the operator shall have the option to select to enable them for an adjustable time period before or after sunset and disable for and adjustable time period before or after sunrise.

Override

Provide a method of manual override in an easily accessible location (i.e., control relay with integral hand-off-auto in control panel).

32. DOMESTIC WATER HEATER

Equipment Control Points

Domestic HW circulation pump enable/disable – DO
Domestic HW heaters enable/disable – DO
Domestic HW circulation pump status – DI
Domestic HW heaters status – DI
Domestic Leaving Water Temp Sensor Status – AI

The BAS shall provide enable/disable control of each gas water heater (GWH). Heaters shall be enabled / disabled based on an operator defined occupancy schedule. A current switch will monitor the status of each system and report back to the BAS.

33. POWER MONITORING

Equipment Control Points

KW input – From Switchgear – BACnet Interface

The BAS shall connect to building electrical switchgear meter and monitor the buildings KWH usage. The B.A.S. control module shall show the current usage, monthly usage, year-to-date usage, and time and date of the highest peak demand for the month and year. Demand thresholds may be set to adjust set-points and shed loads in order to reduce peak consumption.

Alarming

EQUIPMENT SHALL BID AS AN ALTERNATE

The BAS shall provide alarm capabilities when power outages occur. All equipment necessary to accomplish sending alarms via email or text shall be on emergency power.

END OF SECTION 23 09 93

SECTION 23 21 13 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Hot water heating piping.
 - 2. Chilled water piping.
 - 3. Condenser water piping.
 - 4. Make-up water piping.
 - 5. Condensate-drain piping.
 - 6. Blowdown drain piping.
 - 7. Air-vent piping.
- B. Related Sections include the following:
 - 1. Section 23 21 23 "Hydronic Pumps" for pumps, motors, and accessories for Hydronic piping.

1.3 DEFINITIONS

- A. PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be 150 PSI pressure class unless otherwise noted or required by project conditions.

1.5 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Provide flanges, union, and couplings at locations requiring servicing.
- B. Provide unions, flanges, and couplings downstream of valves and at equipment or apparatus connections.
- C. Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- D. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

1.6 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
 2. RTRP and RTRF with adhesive.
 3. Pressure-seal fittings.
- C. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops. The Pipe shop drawings shall be superimposed on the architectural backgrounds.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control test reports.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used.
- E. Test Reports: Indicate results of refrigerant leak test and acid test.
- F. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.

1.8 QUALITY ASSURANCE

- A. All pipe and accessories shall be of United States domestic manufacture.
- B. Installer Qualifications:
 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- C. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

- F. Perform Work in accordance with ASME B31.5 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- G. Maintain one copy of each document on site.
- H. Design piping systems under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Division 1 - General Requirements.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system Protect.
- D. Contractor shall adequately protect piping from damage after delivery to the project. Piping shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- E. Do not deliver piping to the project site until progress of construction has reached the stage where piping is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.10 WELDING

- A. Welding Procedures: Conform to latest recommendations of American Welding Society and Code for Pressure Piping, ANSI B31.1, and current edition. Welding and stress relieving procedures shall conform to Appendix, Section VI, and "Standard Qualifications for Welding Procedures, Welders and Welding Operators."
- B. Locations for Welding: Welding shall not be permitted within occupied area of the building. When the building or a portion of the building is in use as a permanent occupancy welding shall be permitted only in areas physically separated from occupied spaces by fire rated or non-combustible walls to deck or on completely gutted and unoccupied floors.
- C. Fire Protection and Smoke Venting: The Contractor shall provide all manpower and equipment required to protect the building structure and site occupants, other Contractors, etc., from hazards and to remove welding fumes from the building conform to the latest requirements of NFPA 51B.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type B).

- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Housing: Ductile Iron.
 - 2. Gasket: EPDM, Grade EHP
 - 3. Pipe Sizes 2" and larger
 - 4. Tools: Manufacturer's grooving tools.
 - 5. Minimum 300-psig working-pressure rating at 250 deg F.
- C. Copper or Bronze Pressure-Seal Fittings:
 - 1. Housing: Copper.
 - 2. O-Rings and Pipe Stops: EPDM.
 - 3. Pipe Sizes 2" and down
 - 4. Tools: Manufacturer's special tools.
 - 5. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F.
- D. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53 Electric Resistance Weld (ERW), Type E, Grade B, Schedule 40 black steel with plain ends; application as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 250.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedule 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- B. CPVC Plastic Pipe Fittings: Socket-type pipe fittings; ASTM F 439 for Schedule 80 pipe.
- C. PVC Plastic Pipe: ASTM D 1785, Schedule 80, plain ends as indicated in Part 3 "Piping Applications" Article.
- D. PVC Plastic Pipe Fittings: Socket-type pipe fitting; ASTM D 2467 for Schedule 80 pipe.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- F. 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.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - a. CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - a. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - b. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

- H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
- 2. CPVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.

B. Plastic-to-Metal Transition Unions:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX Inc.
 - c. KBi.
 - d. NIBCO INC.
- 2. MSS SP-107, CPVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.6 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 minimum at 180 deg F.

- c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Matco-Norca, Inc.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Wilkins; a Zurn company.
- 2. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: 150 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
- 2. Description:
 - a. Non-conducting 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection.
 - b. Matco-Norca, Inc.
 - c. Precision Plumbing Products, Inc.
 - d. Victaulic Company.
- 2. Description:
 - a. Standard: IAPMO PS 66
 - b. Electroplated steel nipple. Complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig 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, chilled water, and condenser water, above ground, NPS 2 and smaller, shall be the following:
 - 1. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- B. Hot water heating, chilled water, and condenser water above ground, NPS 2-1/2 and larger, shall be one of the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
- C. Makeup-water piping installed aboveground shall be the following:
 - 1. ASTM B 88, Type K (ASTM B 88M, Type B) drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
- D. Condensate-Drain Piping: ASTM B 88, Type L (ASTM B 88M, Type B) hard drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
- E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blow-down drain is installed.
- F. Air-Vent Piping:
 - 1. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, 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 mechanically formed 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 23 05 23 "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- S. 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.
- T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Section 23 05 16 "Expansion Fittings and Loops for HVAC Piping."
- U. Install lateral bracing with pipe hangers and supports to prevent swaying.
- V. Identify piping as specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."
- W. Install sleeves for piping penetrations of walls, ceilings, and floors.
- X. Install mechanical sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for mechanical sleeve seals specified in Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment".
- Y. Sleeve pipe passing through partitions, walls, and floors. Refer to Section 23 05 29 - "Hangers and Supports for HVAC Piping and Equipment".
- Z. Provide access doors where valves and fittings are not accessible.

- AA. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- BB. Provide unions or flanges and isolation valves at each connection to a piece of equipment or control valve; accessory which requires removal for maintenance. Screwed unions should be used for two (2) inches IPS and smaller. Locate joints where they can be accessed for repair. Screw or flanged joints shall not be permitted above inaccessible ceilings or in chases.
- CC. All piping shall be installed to eliminate traps and pockets. Where air pockets or water trap cannot be avoided, provide means for drainage with valved hose connections for water trap and air vents for air pockets. Provide drain valves at low points of the system.
- DD. For pipe inside building, install parallel to lines of building, close to columns and walls vertical pipe shall be truly vertical. Spring or forcing piping into place will not be permitted. Install pipe to prevent strain on equipment connections.
- EE. Provide adequate access to all equipment, motorized valves, instruments, controls, and access panels.
- FF. Allow easy draining of water piping, with drain valves at low points.

3.3 PIPE 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. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- F. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to 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.
- H. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- J. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
 - 4. PVC Non-pressure Piping: Join according to ASTM D 2855.
- K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.4 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall 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 gages and thermometers at coil inlet and outlet connections according to Section 230519 "Meters and Gages for HVAC Piping."

3.5 FIELD QUALITY CONTROL

- A. Prepare Hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, un-insulated 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 shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety 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 shall not 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 "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least one hour, 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.

C. 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.

END OF SECTION 23 21 13

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. End-Suction Split-Coupled Base Mounted Pumps.
 - 2. Pump Suction Diffusers.
- B. Related Sections:
 - 1. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment - Mechanical Vibration Control: Product requirements for vibration isolators required with pumps.

1.3 REFERENCES

- A. Underwriters Laboratories Inc.:
 - 1. UL 778 - Motor Operated Water Pumps.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide pumps electrical characteristics in accordance with Division 26 and schedules on Drawings.

1.5 SUBMITTALS

- A. Submit in accordance with Division 1 and Section 23 05 00.
- B. Provide line-by-line specification review annotated to certify compliance or deviation.
- C. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Provide parallel pump curves indicating the non-overloaded motor horsepower for single pump operation when applicable. Include NPSH curve with operating point plotted when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- D. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

- E. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 CLOSEOUT SUBMITTALS

- A. Submit in accordance with Division 1, General Requirements.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.

1.7 WARRANTY

- A. Furnish one (1) year manufacturer parts and labor warranty for pumps. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or start up will not be acceptable.

1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Spare materials shall be provided by equipment manufacturer and not by the installing mechanical contractor.
 - 1. Furnish one (1) set of mechanical seals for each pump installed.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Pumps shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.

- D. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.11 PUMP IDENTIFICATION REQUIREMENTS

- A. Furnish each pump with a durable, deep etched, .025" thick, factory installed aluminum identification plate, permanently mounted with the following information:
- Unit identification as indicated within Contract Documents.
 - Serial Number.
 - Model Number.
 - Flow rate (GPM) and head (ft. H2O).
 - Motor Horsepower.
 - RPM
 - Power Supply: Volts / PH / Amps.
 - Sales Order #.
 - Date of unit manufactured.
- B. For chilled water pumps, in addition to the base mounted identification tag provide an additional identification tag shipped loose for contractor to install on external rigid insulation board.

PART 2 – PRODUCTS

2.1 END-SUCTION BASE MOUNTED SPLIT-COUPLED PUMPS

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
1. Pentair / Aurora
 2. Armstrong
 3. Bell & Gossett
 4. Patterson
 5. Taco
- B. Type: Horizontal shaft, single stage, direct connected, radial or horizontal split casing, for 175 psig maximum working pressure.
- C. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- D. Impeller: Bronze, fully enclosed, dynamically balanced, and keyed to shaft.
- E. Bearings: Grease or permanently lubricated roller or ball bearings. Bearings shall have 40,000-hour minimum life.
- F. Shaft: 416 stainless steel with stainless steel shaft sleeve.
- G. Seal: Carbon seat rotating against stationary silicon carbide seat, 225 degrees Fahrenheit maximum continuous operating temperature.

- H. Drive: Flexible coupling with OSHA approved coupling guard.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.
- J. Motor: Single speed and rigidly mounted to pump casing.
 - 1. 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.
 - a. Enclosure: Outdoors: Totally enclosed, fan cooled (TEFC).
 - b. Enclosure: Indoors: Open Drip Proof (ODP).
 - c. Efficiency: Premium efficient.
 - d. NEMA Design: MG-1.
 - e. Service Factor: 1.15.

2.2 PUMP SUCTION DIFFUSER

- A. Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. Pentair / Aurora
 - 2. Armstrong
 - 3. Bell & Gossett
 - 4. Patterson
 - 5. Wheatley
 - 6. Taco
- B. Angle pattern, with flanged outlet and inlet connections; grooved connections shall not be acceptable.
- C. 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
- D. Removable stainless steel fine mesh startup and 1/8" perforated stainless-steel star shaped permanent strainers.
- E. Stainless-steel straightening guide vanes.
- F. Drain plug, blow-down tapping in bottom, gage tapping on side.
- G. Factory-fabricated adjustable foot support.
- H. Permanent magnet located in flow stream removable for cleaning.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures and scheduled capacities. Pumps shall operate without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories. Provide no less than the minimum as required by the manufacturer.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping
- D. Equipment Mounting: Install base-mounted pumps on cast-in-place concrete equipment bases.
 - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
 - 2. Construct bases to withstand, without damage to equipment, seismic force required by code.
 - 3. Construct concrete bases 4 high and extend base not less than 6 inches in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or unless required for seismic-anchor support.
 - 4. Install base mounted pumps on concrete inertia base "RBMK" with spring isolators. Refer to section 23 05 48.
- E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.
 - 1. Comply with requirements for seismic-restraint devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 2. Comply with requirements for hangers and supports specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."
- F. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled, split coupled vertical in-line or base mounted pumps; install supports under elbows on pump suction and discharge line sizes four (4) inches and over.
- G. Provide air cock and drain connection on horizontal pump casings.
- H. Provide drains for bases and seals. Route to floor drain.
- I. Lubricate pumps before start-up according to manufacturer's instructions.

3.3 ALIGNMENT (REQUIRED) – APPLIES TO END-SUCTION PUMPS

- A. **Alignment Service shall be performed by a factory authorized direct service technician. Alignment work shall not be performed by installing mechanical contractor or “by other”.**
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout is cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with Drawings and with requirements specified in piping systems. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Discharge side of pumps install flexible connector (for end-suction pumps), non-slam check valve, combination shut-off butterfly valve and throttling valve with memory stop, and thermometer.
- F. Suction side of pumps install suction diffuser with type 304 stainless steel strainer, flexible pipe connector (for end-suction pumps) shut-off butterfly valve on suction side of pumps and thermometer.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping or install single gage with multiple-input selector valve.

3.5 STARTUP SERVICE

- A. Start-up service shall be performed by a factory authorized direct service technician. Start-up work shall not be performed by installing mechanical contractor.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - a. Check piping connections for tightness.
 - b. Clean strainers on suction piping.
 - c. Perform the following startup checks for each pump before starting:

1. Verify bearing lubrication.
2. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
3. Verify that pump is rotating in the correct direction.
- d. Prime pump by opening suction valves and closing drains and prepare pump for operation.
- e. Start motor.
- f. Open discharge valve slowly.

3.6 DEMONSTRATION

- A. Demonstration shall be performed by a factory authorized direct service technician. Demonstration shall not be performed by installing mechanical contractor.
 1. Train owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.
 2. Provide documentation of owner training in close out submittal.

END OF SECTION 23 21 23

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Refrigerant piping.
2. Refrigerant Insulation.
3. Unions, flanges, and couplings.
4. Refrigerant moisture and liquid indicators.
5. Valves.
6. Refrigerant strainers.
7. Refrigerant pressure regulators.
8. Refrigerant pressure relief valves.
9. Refrigerant filter-driers.
10. Refrigerant solenoid valves.
11. Refrigerant expansion valves.
12. Electronic expansion valves.
13. Refrigerant receivers.

B. Related Sections:

1. Section 31 00 00 - Earthwork: Earthwork for backfill in trenches.
2. Section 31 23 16.13 – Trenching and Backfilling: Execution requirements for trenching and backfilling required by this section.
3. Section 07 84 00 - Firestopping: and Fire Safing Product requirements for firestopping for placement by this section.
4. Section 08 31 13 - Access Doors: Access doors for concealed valves and accessories.
5. Section 09 91 00 - Painting and Staining: Product requirements for painting for placement by this section.

6. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports and sleeves for placement by this section.
7. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
8. Section 23 05 53 - Identification for HVAC Piping and Equipment: Product requirements for pipe identification for placement by this section.
9. Section 23 07 19 - HVAC Piping Insulation: Product requirements for Piping Insulation for placement by this section.
10. Section 23 21 13 - Hydronic Piping: Piping materials for refrigerant systems.

1.3 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 1. ARI 495 - Refrigerant Liquid Receivers.
 2. ARI 710 - Liquid-Line Driers.
 3. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Dryers.
 4. ARI 750 - Thermostatic Refrigerant Expansion Valves.
 5. ARI 760 - Solenoid Valves for Use with Volatile Refrigerants.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 1. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- C. American Society of Mechanical Engineers:
 1. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 2. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 3. ASME B31.5 - Refrigeration Piping.
 4. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- D. ASTM International (ASTM):
 1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

3. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
 5. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
- E. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
 2. AWS D1.1 - Structural Welding Code - Steel.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. Underwriters Laboratories Inc.:
1. UL 429 - Electrically Operated Valves.

1.4 PERFORMANCE REQUIREMENTS

- A. Line Test Pressure for Refrigerant R-407C:
1. Suction Lines for Air-Conditioning Applications: 230 psig.
 2. Suction Lines for Heat-Pump Applications: 380 psig.
 3. Hot-Gas and Liquid Lines: 380 psig.
- B. Line Test Pressure for Refrigerant R-410A:
1. Suction Lines for Air-Conditioning Applications: 300 psig.
 2. Suction Lines for Heat-Pump Applications: 535 psig.
 3. Hot-Gas and Liquid Lines: 535 psig.

1.5 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections when joining dissimilar metals in systems.
- B. Provide flanges, unions, or couplings at locations requiring servicing. Use unions, flanges, or couplings downstream of valves and at equipment connections. Do not use direct welded or threaded connections to valves or equipment.
- C. Provide pipe hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- D. Provide receivers sized to accommodate pump down charge.

- E. Flexible Connectors: Use at or near compressors where piping configuration does not absorb vibration.

1.6 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Submit in Accordance with Division 1 - General Requirements.
- C. When manufacturer's cut sheets apply to a product series rather than a specific product, clearly indicate applicable data by highlighting or by other means. Clearly reference covered specification and drawing on each submittal. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Select and show specific pertinent performance data and quantities appropriate to scope of work.
- D. Shop Drawings: Indicate layout of refrigeration piping system, including equipment, critical dimensions, and sizes.
- E. Product Data:
 - 1. Piping: Submit data on pipe materials, fittings, and accessories.
 - 2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
 - 3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
 - 4. Refrigerant Specialties: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes for the following:
 - a. Refrigerant moisture and liquid indicators.
 - b. Refrigerant strainers.
 - c. Refrigerant pressure regulators.
 - d. Refrigerant pressure relief valves.
 - e. Refrigerant filter-driers.
 - f. Refrigerant solenoid valves.
 - g. Refrigerant expansion valves.
 - h. Electronic expansion valves.
- F. Test Reports: Indicate results of piping system pressure test.
- G. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- H. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

- I. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of valves, equipment, and refrigerant accessories.
- B. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three (3) years experience.
- B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three (3) years experience approved by manufacturer.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Division 1- General Requirements.
- B. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.
- C. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- F. Contractor shall adequately protect material from damage after delivery to the project. Piping shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- G. Do not deliver Piping to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected,

and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.11 WARRANTY

- A. Furnish five (5) year manufacturer warranty for valves excluding packing.

1.12 MAINTENANCE MATERIALS

- A. Furnish two (2) refrigerant oil test kits each containing everything required for conducting one test.

1.13 EXTRA MATERIALS

- A. Furnish two (2) packing kits for each size and valve type.
- B. Furnish two (2) refrigerant filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

- A. Copper Tubing: ASTM B 280, Nitrogenized Type L - ACR hard drawn.
 - 1. Wrought-copper Fittings: ASME B16.22.
 - 2. Brazing Filler Metals: AWS A5.8. BCuP: minimum 15% silver (Ag), 5% phosphorous (P), and balance copper (Cu).
 - 3. Final product composition shall be 99% pure copper and lead free.
 - 4. Provide in 10 ft. and 20 ft. straight tube lengths.
 - 5. **Bendable pipe of any kind shall not be accepted.**

2.2 UNIONS, FLANGES, AND COUPLINGS

- A. Two (2) inches and Smaller:
 - 1. Copper Pipe: Bronze, soldered joints.
- B. 2-1/2 inches and Larger:
 - 1. Copper Piping: Bronze
 - 2. Gaskets: 1/16-inch-thick preformed neoprene.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.3 REFRIGERANT MOISTURE AND LIQUID INDICATORS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 - 3. Sporlan Valve Co.
- B. Indicators:
 - 1. Port: Single, UL listed.
 - 2. Body: Brass, solder ends.
 - 3. Sight glass: Color-coded paper moisture indicator with removable element cartridge and plastic cap.
 - 4. Maximum working pressure: 500 psig
 - 5. Maximum working temperature: 200 degrees Fahrenheit.

2.4 VALVES

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Alco Controls Div, Emerson Electric Co.
 - 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 - 3. Sporlan Valve Co.
- B. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet solder or flared ends.
 - 2. Phosphor bronze and stainless-steel diaphragms, rising stem and hand wheel.
 - 3. Stainless steel spring, nylon seats, disc with positive back seating.
 - 4. Maximum working pressure: 500 psig
 - 5. Maximum working temperature: 275 degrees Fahrenheit.
- C. Packed Angle Valves:
 - 1. Forged brass, solder ends.
 - 2. Forged brass seal caps with copper gasket, rising stem and seat with back seating, molded stem packing.
 - 3. Maximum working pressure: 500 psig

4. Maximum working temperature: 275 degrees Fahrenheit.
- D. Ball Valves:
1. Two piece bolted forged brass body with Teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals, soldered ends.
 2. Maximum working pressure: 500 psig and
 3. Maximum working temperature: 300 degrees Fahrenheit.
- E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, solder ends.
 2. Maximum working pressure: 500 psig.
- F. Refrigerant Check Valves:
1. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - a. Alco Controls Div, Emerson Electric Co.
 - b. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 - c. Sporlan Valve Co.
 2. Globe Type:
 - a. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless-steel spring, Teflon seat disc.
 - b. Maximum working pressure: 500 psig.
 - c. Maximum working temperature: 300 degrees Fahrenheit.
 3. Straight Through Type:
 - a. Spring, neoprene seat.
 - b. Maximum working pressure: 500 psig.
 - c. Maximum working temperature: 250 degrees Fahrenheit.

2.5 REFRIGERANT STRAINERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division

3. Sporlan Valve Co. Model.
- B. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless-steel wire or monel reinforced with brass.
 2. Maximum working pressure: 430 psig.

2.6 REFRIGERANT PRESSURE REGULATORS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 3. Sporlan Valve Co.
- B. Brass body, stainless steel diaphragm, pilot operated with remote pressure pilot, adjustable over 0 to 80 psig range, for maximum working pressure of 450 psig.

2.7 REFRIGERANT PRESSURE RELIEF VALVES

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division.
 3. Sporlan Valve Co.
- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; setting selected to ASHRAE 15.

2.8 REFRIGERANT FILTER-DRIERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 3. Sporlan Valve Co.
- B. Replaceable Cartridge Angle Type:
1. Shell: ARI 710, UL listed, steel, removable cap, for maximum working pressure of 500 psig, and wrought copper fittings for solder end connections.

2. Filter Cartridge: Pleated media with integral end rings, stainless steel support.
 3. Filter/Dryer Cartridge: Pleated media with solid core sieve with activated alumina to provide micronic filtration.
 4. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets.
- C. Permanent Straight Through Type:
1. ARI 710, UL listed, steel shell with molded desiccant filter core, for maximum working pressure of 500 psig.
 2. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

2.9 REFRIGERANT SOLENOID VALVES

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 3. Sporlan Valve Co.
- B. Valve: ARI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly, integral strainer, solder ends; for maximum working pressure of 500 psig. Stem designed to allow manual operation in case of coil failure.
- C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture, and fungus proof, with surge protector and color-coded lead wires, integral junction box.

2.10 REFRIGERANT EXPANSION VALVES

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Alco Controls Div, Emerson Electric Co.
 2. Parker Hannifin Corp., Refrigeration & Air Conditioning Division
 3. Sporlan Valve Co.
- B. Angle or Straight Through Type: ARI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum ten (10) degrees Fahrenheit superheat. Select to avoid being undersized at full load and oversized at part load.

2.11 REFRIGERANT PIPING INSULATION

- A. Insulate suction lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
 - 1. Do not install insulation until system testing has been completed and all leaks have been eliminated.
 - 2. Insulation shall be Armaflex Ultima pipe insulation. Provide 1-inch insulation thickness. All seams and joints shall be adhered and sealed using Armaflex 520 adhesive. All fittings shall be insulated with same insulation thickness as straight pipe.
 - 3. **Exposed refrigerant liquid and suction piping (located indoors and/or outdoors)**; shall be insulated and include two (2) coats of WB Armaflex Finish. In addition, liquid and suction lines shall be provided with aluminum jacketing; provide 0.016-inch Type 3105 on all exterior insulated piping. Fitting covers shall be 0.024-inch Type 1100 aluminum. Jacketing and fitting covers shall be banded with 0.20-inch Type 3105, 1/2-inch-wide banding with 0.32-inch Type 5005 wing seals on 12-inch centers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

- A. Route piping parallel to building structure and maintain gradient.
- B. Install piping to conserve building space, and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Sleeve pipe passing through partitions, walls, and floors. Refer to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- E. Install pipe identification in accordance with Section 23 05 53 - Identification for HVAC Piping and Equipment.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- G. Arrange refrigeration piping to return oil to compressor. Provide traps and loops in piping, and where necessary provide double risers. Slope horizontal piping 0.40 percent in direction of flow.
- H. Provide access where valves and fittings are not exposed.
- I. Flood refrigerant piping system with nitrogen when brazing.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 00.
- L. Install valves with stems upright or horizontal, not inverted.
- M. Provide replaceable cartridge filter-dryers, with isolation valves and bypass with valve.
- N. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- O. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- P. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- Q. Provide electrical connection to solenoid valves.
- R. Fully charge completed system with refrigerant after testing.
- S. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- T. Install refrigerant piping in accordance with ASME B31.5.
- U. Install piping in as short and direct arrangement as possible to minimize pressure drop.
- V. Install piping with minimum number of joints using as few elbows and other fittings as possible.
- W. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.
- X. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.
- Y. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.
- Z. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

- AA. Slope refrigerant piping as follows:
1. Install horizontal hot gas discharge piping with 1/2 inch per ten (10) feet downward slope away from the compressor.
 2. Install horizontal suction lines with 1/2 inch per ten (10) feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.
 3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.
 4. Liquid runs
- BB. Use fittings for all changes in direction and all branch connections.
- CC. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.
- DD. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
- EE. Conceal all pipe installation in walls, pipe chases, utility spaces, above ceilings, below grade floors, unless indicated to be exposed to view.
- FF. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with one (1) inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
- GG. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing or valves.
- HH. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than six (6) inches shall be steel; pipe sleeves six (6) inches and larger shall be sheet metal.
- II. Fire Barrier Penetrations: Seal pipe penetrations through fire rated wall, partitions, ceilings, and floors, maintain the fire rated integrity.
- JJ. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.
- KK. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.
- LL. Install moisture / liquid indicators in liquid lines between filter / driers and thermostatic expansion valves and in liquid line to receiver.
1. Install moisture / liquid indicators in lines larger than 2-1/8-inch OD, using a bypass line.

MM. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

NN. Install flexible connectors at the inlet and discharge connection of compressors.

3.3 INSTALLATION - REFRIGERANT SPECIALTIES

A. Refrigerant Liquid Indicators:

1. Install line size liquid indicators in main liquid line downstream of condenser.
2. When receiver is provided, install line size liquid indicators in liquid line downstream of receiver.
3. Install line size liquid indicators downstream of liquid solenoid valves.
4. Install liquid indicator on leaving side of filter-driers.

B. Refrigerant Valves:

1. Install service valves on compressor suction and discharge.
2. Install gage taps at compressor inlet and outlet.
3. Install gage taps at hot gas bypass regulators, inlet, and outlet.
4. Install check valves on compressor discharge.
5. Install check valves on condenser liquid lines on multiple condenser systems.
6. Install refrigerant charging valve in liquid line between receiver shut-off valve and expansion valve.

C. Strainers:

1. Install line size strainer upstream of each automatic valve.
2. Where multiple expansion valves with integral strainers are used, install single main liquid-line strainer.
3. On steel piping systems, install strainer in suction line.
4. Install shut-off valves on each side of strainer.

D. Install pressure relief valves on ASME receivers. Install relief valve discharge piping to terminate outdoors.

E. Filter-Dryers:

1. Install permanent filter-dryers in low temperature systems.
2. Install permanent filter-dryer in systems containing hermetic compressors.
3. Install replaceable cartridge filter-dryer vertically in liquid line adjacent to receivers.

4. Install replaceable cartridge filter-dryer upstream of each solenoid valve.

F. Solenoid Valves:

1. Install in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Install in liquid line of single or multiple evaporator systems.
3. Install in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.

3.4 PIPE JOINT CONSTRUCTION

- A. Brazed Joints: Comply with the procedures contained in the AWS: Brazing Manual".
1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
 2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.
- B. Pressurize the pipe and fittings during brazing with nitrogen to prevent formation of harmful oxides.
- C. Heat joints using-acetylene torch. Heat to proper and uniform brazing temperature.

3.5 VALVE INSTALLTIONS - GENERAL

- A. General: Install refrigerant valves in accordance with manufacturer's instructions.
- B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.
- C. Install a full sized, 3-valve bypass around each drier.
- D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.
1. Coordinate electrical requirements and connections.
- E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.
1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.
 2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.

3. Secure the bulb straps. Do not mount bulb in a trap or at the bottom of the line.
 4. Where external equalizer lines are required make the connection where it clearly reflect the pressure existing in the suction line at the bulb location.
- F. Install pressure regulating and relieving valves required by ASHRAE Standard 15.

3.6 EQUIPMENT CONNECTIONS

- A. Install piping adjacent to machine to allow servicing and maintenance.

3.7 FIELD QUALITY CONTROL

- A. Install, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI.
- B. Repair leaking joints using new materials and retest for leaks.

3.8 CLEANING

- A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedures:
1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
 2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
 3. Draw a clean, lintless cloth saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint.
 4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.9 ADJUSTING AND CLEANING

- A. Verify actual evaporator applications and operating conditions and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.
- B. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.10 SYSTEM CHARGING

- A. Charge system using the following procedure:
1. Install core in filter dryer after leak test but before evacuation.
 2. Evacuate entire refrigerant system with a vacuum pump to 500 microns. When vacuum holds for a minimum of 24 hours, system is ready for charging.
 3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
 4. Break vacuum with refrigerant gas, allow pressure to build up to 2 psig.

- 5. Charge system with a new filter-dryer core in charging line.
- B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, trouble shooting, servicing, and preventive maintenance of refrigerant piping valves and refrigerant piping specialties.
- C. Review data in Operating and Maintenance Manuals.
- D. Schedule training with Owner with at least seven (7) days advance notice.

END OF SECTION 23 23 00

SECTION 23 25 13 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

- B. The requirements of the General Conditions and Supplementary Conditions apply to all work herein.
- C. The Common Work Results for HVAC, Section 23 05 00, are included as a part of this Section as though written in full in this document.

1.3 SCOPE

- A. Scope of the Work shall include the furnishing and complete installation of the equipment covered by this Section, with all auxiliaries, ready for owner's use.

1.4 DESCRIPTION OF WORK

- A. Work Included: Perform water analysis and provide all water treatment products, holding reservoirs, equipment and labor for testing, cleaning, flushing and dispensing products to control water quality for each system specified hereinafter as follows:
 - 1. Chilled Water Systems
 - 2. Heating Water Systems
- B. Chemicals: Provide, at no additional cost to the Owner, all chemicals required for operating and testing all water treatment systems prior to and for three months after acceptance by the Owner.
- C. Instructions: Provide operating and maintenance instructions for each water treatment system; include one set in each Owner's Manual and deliver one set to Owner's operating personnel.
- D. Testing Equipment and Reagents: Furnish suitable water treatment equipment for each system, complete with apparatus and reagents necessary for operation prior to and for three months after acceptance by the Owner.
- E. Service Representative: Furnish the services of a qualified service representative to instruct Owner's operating personnel in proper operation and maintenance of water treatment equipment, systems and tests required. Service representative shall return to the site bi-weekly during first 2 months of operation and monthly during the remainder of the guarantee period. At such time, service representative shall check and adjust water treatment system operation, check efficiency of chemicals and chemical applications, and instruct and advise operating personnel.
- F. Replacement and Rework: Replace defective or nonconforming materials and equipment with new materials and equipment at no additional cost to the Owner for 1 year after successful start-up of the system. All warranty work shall be FOB as installed at the project site.

1. Guarantee: Provide system produced by manufacturer who is willing to execute the required guarantee.
2. Agreement to Maintain: Provide system produced by manufacturer who is willing to execute (with the Owner) the required agreement for continued maintenance of the system.

1.5 QUALITY ASSURANCE

- A. Qualifications: The Contractor for work under this Section shall have:
 1. Research and development facilities.
 2. Regional laboratories capable of making water analysis.
 3. A service department and qualified technical service representative located within a reasonable distance of the project site.
 4. Service representatives who are Registered Engineers or factory-certified technicians with not less than 5 years of water treatment experience with the water treatment system manufacturer.
- B. Packaging and Labeling: Supply water treatment chemicals in metal drums, fiber drums with plastic liners, or plastic lined "liqui-paks" as best suited to the materials. Paper bags or unlined cardboard cartons will not be acceptable. Use only chemicals in domestic water systems, all coincides regardless of where used, which are registered with the U.S. Department of Agriculture (USDA) or the U.S. Environmental Protection Agency (EPA) and which are labeled as required by law.
- C. Electrical Standards: Provide electrical products which have been tested, listed and labeled by Underwriters Laboratories (UL) and which comply with National Electrical Manufacturers' Association (NEMA) standards.
- D. Chemical Standards: Provide chemical products acceptable under state and local pollution control or other governing regulations.

1.6 SUBMITTALS

- A. Test reports: Submit test reports certified by an officer of the firm, on water treatment company letterheads, of samples of each treated water system specified. Comply with ASTM D 596 for reporting. Indicate the ASTM best methods for each test.
- B. Shop Drawings: Submit shop drawings for each water treatment system. Show wiring, piping, and tubing sizes, fittings, accessories, valves and connections.
- C. Guarantee: Submit written guarantee signed by the Manufacturer and countersigned by the Installer and Contractor, agreeing to adjust or replace the chemicals in the systems as required achieving the required performance, during a 1-year period following the final start-up or the continued operation of the chillers.
- D. Agreement to Maintain: Prior to the time of final acceptance, the Manufacturer of the chilled water treating system shall submit four copies of an "Agreement for Continued Service and the Owner's possible acceptance." Offer terms and conditions for furnishings

chemicals and providing continued testing and equipment for a 1-year period with option for renewal of the Agreement by Owner.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.

1. Worth Hydrochem of Houston.

2.2 GENERAL

- A. Water Analysis: Determine which chemicals to use from the results of a water sample analysis taken from the building site by the system manufacturer. Provide ingredients necessary to achieve the desired water conditions.

- B. Pre-Treatment: For new construction and/or renovations to existing Hydronic systems treat chilled and heating water piping systems with chemicals to remove and permit flushing of mill scale, oil, grease, and other foreign matter. Chemicals shall be equal to Nalco 2578 prepping compound. A school district supervisor is to be present to observe cleaning of chilled and heating water piping systems. SYSTEMS SHALL NOT BE STARTED UP UNTIL THE PIPING HAS BEEN CLEANED.

CLEANING OF CHILLED AND HEATING WATER PIPING SYSTEMS:

1. General cleaning of piping systems. Purge pipe of construction debris and contamination before placing the system in service. Provide and install temporary connections as required to clean, purge, and circulate. Flush the chilled and hot water systems utilizing the filter feeders.
2. Install temporary strainers at the inlet of pumps and other equipment as necessary where permanent strainers are not indicated. Keep strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blow down ball valve and pipe to nearest drain. Blow down strainers, remove and clean as frequently as necessary.
3. Phase One: initial flushing of system. Remove loose dirt, mill scale, weld heads, rust, and other deleterious substances without damage to system components. Open valves, drains, vents, and strainers at all system levels during flushing procedures. Flush until "potable water clear" and particles larger than 5 microns are removed.
4. Connect dead-end supply and return headers, even if not shown on the drawings, and provide terminal drains in bottom of pipe end caps or blind flanges.
5. Dispose of water in approved manner.
6. Phase Two: Cleaning of piping system. Remove, without chemical or mechanical damage to any system component, adherent dirt (organic soil), oil, grease, (hydrocarbons), welding and soldering flux, and Mill varnish, piping components, rust (iron oxide) and other deleterious substances not removed by initial flushing. Chemical shall be approved equivalent to Nalco 2578 prepping compound. Insert anti-foam compound, as necessary. Circulate for 48 hours or as recommended by the manufacturer. Dispose of water in an approved manner. Flush system and replace with clean water. Verify compatibility of chemicals used with existing

chemical treatment program on remodel projects. For aluminum heat exchangers within condensing boiler, maintain pH less than 8.5, per manufacturer's recommendations.

7. Phase Three: Final flushing and rinsing until "potable water clear" and particles larger than 5 microns are removed. Operate valves to dislodge any debris in valve body. Dispose of water in approved manner.
 8. Submit status report upon completion of each phase of work on each system.
 9. Special requirements, if any, are specified in the sections on each type of piping.
- C. FDA and USDA Approval: use only FDA and USDA-approved products in system with direct connection to domestic water systems.
- D. Governing Laws: Ensure that neither products, waste, blow-down nor other effluents violate local, state, EPA, or other agency regulations in effect in the project area.

2.3 CHILLED AND HEATING WATER SYSTEMS

- A. Chemicals: Provide water treatment products which contain inhibitors that perform the following:
1. Form a protective film to prevent corrosion and scale formation to maintain iron levels between 0.0 and 0.5 as Fe.
 2. Scavenge oxygen and protect against scale
 3. Remain stable throughout operating temperature range
 4. Are compatible with pump seals and other elements in the system.
 5. For aluminum condensing boilers, molybdate at 10 to 25 ppm and maintain pH limit below 8.5; refer to boiler manufacturer's recommendation.
 6. Chilled Water Loop: The inhibitor shall be a boron-nitrate scale inhibitor compound at 650 to 750 ppm as NO₂ (Nitrite); pH of 9.5 to 10.5; and to maintain Fe (Iron) levels between 0.0 and 0.5 ppm.
 7. Heating Water Loop: The inhibitor shall be a boron-nitrate scale inhibitor compound at 750 to 1,000 ppm as NO₂ (Nitrite); pH of 9.5 to 10.5; and to maintain Fe (Iron) levels between 0.0 and 0.5 ppm.
- B. Equipment: Provide a bypass feeder with a 5-gallon capacity. The feeder shall be constructed of 10-gauge steel and impervious to the products dispensed. Tank heads shall have a minimum of 9-gauge steel and shall be rated at 300 psi and to 200°F. Chemical feeder shall have inlet and outlet drain valves with full bottom drain. The tank shall have a wide mouth, 3-1/2" opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. Closures rated less than 300 psi shall not be considered equal.

The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal. The ring gasket shall not be glued or

restrained from movement. Closures using "o" rings or gaskets which are glued or restrained from free movement by snap rings shall not be considered equal.

Provide bypass feeder with legs to elevate the feeder off of the floor. The legs shall have holes to allow mounting to anchor bolts.

The bypass feeder shall be provided with a 5-micron filter bag fully supported by a stainless-steel filter basket for simultaneous side stream filtering.

1. Acceptable Manufacturer: Neptune, model FTF-5DB.

C. Test Kit: Provide test kit and reagents for determining proper water conditions.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS PREPARATION:

- A. General: After piping systems are erected and proven free of leaks, administer chemicals required for preparation treatment and flushing. Apply chemicals for the time period and in the concentration recommended by the water treatment manufacturer for this portion of the work.
- B. Testing: Perform test procedures and submit a written report of test conditions and results to the Engineer. If test results are unsatisfactory, repeat preparation treatment as necessary to achieve test results approved by the Owner's insurance carrier and the Engineer.

3.2 FLUSHING:

- A. Drain preparation and boil out products from the systems. Flush with clean water until system tests prove systems are free of preparation and boil out products and other contaminants prior to administering system water treatment as specified hereinbefore.

3.3 CHILLED AND HEATING WATER SYSTEM:

- A. Treatment: Treat initial water charge to chilled water loop at 650-750 ppm as NO₂ and heating water loop at 750 to 1000 as NO₂ water systems, after system has been flushed and prepped, to achieve a water quality as specified.
- B. Start-up Procedures: During chilled and heating water system start-up, operate chilled and heating water treating systems (after charging with specified chemicals) to maintain the required steady-state characteristics of cooling and heating water. Demonstrate system operation to Owner's operating personnel.
- C. Reports: Prepare certified test report for each required water performance characteristic. Comply with the following ASTM standard, where applicable:
 - 1. D 859 - Tests for Silica in Water and Water Waste
 - 2. D 1067 - Tests for Acidity or Alkalinity of Water
 - 3. D 1068 - Tests for Iron in Water and Wastewater
 - 4. D 1126 - Tests for Hardness in Water

5.	D	1128	-	Tests for Identification of Types of Microorganisms and Microscopic Matter in Water and Wastewater
6.	D	3370	-	Sampling Water
- D. Water Chemistry: Where water chemistry substantiates that pH is not necessary, chemical fee shall be based on water makeup qualities. Water analysis shall be based on the full parameters of operation, and all possible water supplies. Total hardness and "M" alkalinity of the makeup water will be the determining factor along with the technical limitations of the inhibitors.

3.4 PERSONNEL TRAINING:

- A. Operator Training: Train Owner's personnel in use and operation of heating water, chilled water treating systems including preparation of chemical solution reservoir. A Program Administration Manual shall be furnished encompassing all systems in this section of the Specifications.

END OF SECTION 23 25 13

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round and Flat Oval ducts and fittings.
 - 3. Double-wall rectangular ducts and fittings.
 - 4. Double-wall round and Flat Oval ducts and fittings.
 - 5. Double-wall flat oval / round / rectangular outdoor ductwork.
 - 6. Insulated Flexible Ducts
 - 7. Sheet metal materials.
 - 8. Sealants and gaskets.
 - 9. Hangers and supports.
- B. Related Sections:
 - 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
 - 3. Division 23 Section "Duct Insulation" for internal duct liner.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: For each type of the following products:

1. Adhesives.
2. Sealants and gaskets.

C. 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. $\frac{1}{4}'' = 1'-0''$ Scale Duct layout drawings indicating sizes, configuration, liner material, static-pressure classes, and bottom of duct elevations. Duct shop drawings shall be superimposed on the architectural backgrounds with the reflected ceiling plans.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.

5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports, and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Open ends of ductwork shall be factory shrink wrapped air and watertight before shipment to jobsite.
- B. Contractor shall adequately protect ductwork from damage after delivery to the project. Ductwork shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver ductwork to the project site until progress of construction has reached the stage where ductwork is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Envirotech Mechanical Systems
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.
 5. McCorvey Sheet Metal Works
 6. Titan Metals
 7. Telkin Sheetmetal, Inc.
 8. Tomball Sheet Metal Co.
 9. MLN
 10. Walsh & Albert
 11. Grant Sheet Metal
 12. Tennapel Sheet Metal
 13. McGill AirFlow LLC.
 14. Texas Duct Systems
 15. South Texas Sheet Metal
 16. Texas Air Duct Systems
 17. SEMCO Incorporated
 18. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. Sheet Metal Connectors, Inc
- D. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- E. Transverse Joints: Select joint types and fabricate according to 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."
- F. Longitudinal Seams: Select seam types and fabricate according to 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."
- G. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 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 SINGLE-WALL ROUND AND FLAT OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Envirotech Mechanical Systems
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.
 5. McCorvey Sheet Metal Works
 6. Telkin Sheetmetal, Inc.
 7. Titan Metals
 8. Tomball Sheet Metal Co.
 9. MLN
 10. Walsh & Albert
 11. Grant Sheet Metal
 12. Tennapel Sheet Metal
 13. McGill AirFlow LLC.
 14. Texas Duct Systems
 15. South Texas Sheet Metal
 16. Texas Air Duct Systems
 17. SEMCO Incorporated
 18. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
- D. Triple-Rib shall be acceptable for single wall spiral lockseam ducts: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round 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. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round 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."
1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

- G. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," 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."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Envirotech Mechanical Systems
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.
 5. McCorvey Sheet Metal Works
 6. Telkin Sheetmetal, Inc.
 7. Titan Metals
 8. Tomball Sheet Metal Co.
 9. MLN
 10. Walsh & Albert
 11. Grant Sheet Metal
 12. Tennapel Sheet Metal
 13. McGill AirFlow LLC.
 14. Texas Duct Systems
 15. South Texas Sheet Metal
 16. Texas Air Duct Systems
 17. SEMCO Incorporated
 18. Lindab Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to 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."
- E. Longitudinal Seams: Select seam types and fabricate according to 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."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg. F mean temperature.

2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg. F mean temperature.
- H. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to 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."
- J. Longitudinal Seams: Select seam types and fabricate according to 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."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Envirotech Mechanical Systems
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.
 5. McCorvey Sheet Metal Works
 6. Telkin Sheetmetal, Inc.
 7. Titan Metals
 8. Tomball Sheet Metal Co.
 9. MLN
 10. Walsh & Albert
 11. Grant Sheet Metal
 12. Tennapel Sheet Metal
 13. McGill AirFlow LLC.
 14. Texas Duct Systems
 15. South Texas Sheet Metal
 16. Texas Air Duct Systems
 17. SEMCO Incorporated
 18. Lindab Inc.
- B. Fabricate ducts with indicated dimensions for the inner duct.

- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
- D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round 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."
 - a. Transverse Joints in Ducts Larger Than 60 Inches Diameter: Flanged.
 - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round 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."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
 - 3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," 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."
- E. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch- diameter perforations, with overall open area of 23 percent.
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - 1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg F mean temperature.
 - 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - 3. Coat insulation with antimicrobial coating.
 - 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B.
 - 1. Maximum Thermal Conductivity: $K = 0.23$ at 75 deg F mean temperature.

2.5 DOUBLE-WALL FLAT OVAL / ROUND / RECTANGULAR OUTDOOR DUCTWORK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Envirotech Mechanical Systems
 2. Gurry Mechanical L.P.
 3. Letsos Company
 4. Mason Road Sheet Metal Inc.
 5. McCorvey Sheet Metal Works
 6. Telkin Sheetmetal, Inc.
 7. Titan Metals
 8. Tomball Sheet Metal Co.
 9. MLN
 10. Walsh & Albert
 11. Grant Sheet Metal
 12. Tennapel Sheet Metal
 13. McGill AirFlow LLC.
 14. Texas Duct Systems
 15. South Texas Sheet Metal
 16. Texas Air Duct Systems
 17. SEMCO Incorporated
 18. Lindab Inc.
 19. Linx.
- B. Fabricate ducts with indicated dimensions for the inner duct.
- C. Material:
1. Outer Duct: 18-gauge epoxy coated galvanized duct.
 2. Material thickness constructed in accordance with latest SMACNA's HVAC Duct Construction Standards.
- D. Inner Duct: 20 gauge perforated galvanized duct.
- E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B.
1. Minimum 2" insulation and R-value of 8 at 75°F mean ambient temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
- F. Exterior Coating / Finish.
1. Epoxy coated exterior duct.
 2. Average thickness of 4 mils to meet or exceed 3,000-hour salt spray test per ASTM B17-97.

3. Coordinate color with the architect and the owner.

2.6 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thermaflex Type M-KE.
 - b. Atco
- B. Product Description: UL 181, Class 1, CPE fabric attached to helical wound spring galvanized steel wire; fiberglass insulation; aluminized vapor barrier film.
 - a. Pressure Rating: six (6) inches wg positive and four (4) inches wg negative.
 - b. Maximum Velocity: 4,000 fpm.
 - c. Temperature Range: -20 degrees Fahrenheit to 210 degrees Fahrenheit.
 - d. Thermal Resistance: Minimum R-6 installed.
 - e. Maximum flexible duct length shall not exceed 5'-0".
- C. Provide Flexible Duct Elbow Supports at each diffuser. Refer to "23 33 00 Air Duct Accessories"; 2.10 Flexible Duct Elbow Supports.

2.7 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 shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G90 (Z275).
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches.

2.8 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. 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.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
 - 6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated 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 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Duct straps shall be wrapped from the top cord of joists; straps wrapped from the bottom chord will not be accepted.

- E. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- F. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- G. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- H. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- I. 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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.

- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- M. Ductwork installed on the roof shall be installed and supported such that the roof may be maintained / repaired without the need to disassemble any ductwork.

3.2 REQUIREMENTS FOR DRYER EXHAUST DUCTS

- A. Dryer exhaust ducts for clothes dryers shall be smooth, rigid galvanized duct and shall terminate on the outside of the building and shall be equipped with a backdraft damper. Ducts shall not be connected or installed with sheet metal screws or other fasteners that will obstruct the exhaust flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent, or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums. Provide weather resistant stainless-steel wall cap at duct / wall penetration and a minimum 8" relief hood at roof penetration with roof curb, flashing and counter flashing.

3.3 REQUIREMENTS 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 the 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.

3.4 ADDITIONAL REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and sloped a minimum of 2 percent to drain grease back to the hood.
- B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.5 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.6 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. For fastening of sheet metal support straps on each side of the duct, provide (2) two sheet metal screws on the side of the duct and (1) one on the bottom of the duct for a total of (6) six sheet metal screws for maximum fastening of strap to sheet metal duct.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "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 interval 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.

3.7 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 PAINTING

- A. Paint all outdoor ductwork, exposed ductwork and exterior of metal ducts that are visible through cloud ceilings, registers, and grilles, etc. and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer; refer to paint manufacturer's instructions to prevent peeling. Coordinate final paint color with architect. Paint materials and application requirements are specified in Division 09 painting Sections.

3.9 DUCT STORAGE / CLEANING

- A. Ductwork shall be kept clean at all times. Ductwork stored on the job site shall be placed a minimum of 4" above the floor and shall be completely covered in plastic with no exposed ends. Installed ductwork shall be protected with plastic. Do not install the ductwork if the building is not "dried-in". If this is required, the entire lengths of duct shall be covered in plastic for protections. The Owner / Engineer shall periodically inspect that these procedures are followed. If deemed unacceptable, the Contractor shall be required to clean the duct system utilizing NADCA certified Contractor.
- B. The working area shall be clean, dry and the ductwork protected from dust. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.

3.10 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
 - 1. All exposed ducts in spaces such as but not limited to: Gymnasiums, Natatoriums, Cafeteria's, Libraries, etc.: Double wall insulated round ductwork.
- B. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Split-DX System Air Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 1-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 12.
 - 2. Ducts Connected to Constant-Volume Air-Handling and Rooftop Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 6.

3. Ducts Connected to Variable-Air-Volume Air-Handling and Rooftop 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: 3.

C. Return and Outside Air Ducts:

1. Ducts Connected to Fan Coil Units, Split-DX System Air Units Furnaces, Heat Pumps, and Terminal Units:

- a. Pressure Class: Positive or negative 1-inch wg.
- b. Minimum SMACNA Seal Class: C.
- c. SMACNA Leakage Class for Rectangular: 24.
- d. SMACNA Leakage Class for Round: 12.

2. Ducts Connected to Air-Handling and Rooftop Units:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: B.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

- a. Pressure Class: Negative 1-inch wg.
- b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round: 6.

2. Ducts Connected to Air-Handling and Rooftop Units:

- a. Pressure Class: Positive or negative 2-inch wg.
- b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

- a. Exposed to View: 18-gauge Type 304, stainless-steel sheet, No. 4 finish.
- b. Concealed: 16-gauge Carbon-steel sheet.
- c. Continuously welded seams and joints
- d. Pressure Class: Positive or negative 2-inch wg.
- e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
- f. SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:

- a. 18-gauge Type 304, stainless-steel sheet.
- b. Exposed to View: No. 4 finish.

- c. Concealed: No. 2D finish.
 - d. Continuously welded seams and joints
 - e. Pressure Class: Positive or negative 2-inch wg.
 - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - g. SMACNA Leakage Class: 3.
5. Ducts Connected to Shower Return air grilles:
- a. 18-gauge Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - d. Continuously welded seams and joints
 - e. Pressure Class: Positive or negative 2-inch wg.
 - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - g. SMACNA Leakage Class: 3.
6. Ducts Connected to Fans Exhausting Laboratory and Process (ASHRAE 62.1, Class 3 and 4) Air:
- a. Type 316, stainless-steel sheet.
 - 1. Exposed to View: No. 4 finish.
 - 2. Concealed: No. 2D finish.
 - b. Continuously welded seams and joints
 - c. Pressure Class: Positive or negative 3-inch wg.
 - d. Minimum SMACNA Seal Class: A.
 - e. SMACNA Leakage Class: 3.
7. Ducts Connected to Chlorine and Acid Rooms (ASHRAE 62.1, Class 3 and 4) Air:
- a. Type 316, stainless-steel sheet.
 - 1. Exposed to View: No. 4 finish.
 - 2. Concealed: No. 2D finish.
 - b. Continuously welded seams and joints
 - c. Pressure Class: Positive or negative 3-inch wg.
 - d. Minimum SMACNA Seal Class: A.
 - e. SMACNA Leakage Class: 3.
8. Ducts Connected to Fans Exhausting Welding Fumes (ASHRAE 62.1, Class 3 and 4) Air:
- a. Type 316, stainless-steel sheet.
 - 1. Exposed to View: No. 4 finish.
 - 2. Concealed: No. 2D finish.
 - b. Continuously welded seams and joints
 - c. Pressure Class: Positive or negative 3-inch wg.
 - d. Minimum SMACNA Seal Class: A.
 - e. SMACNA Leakage Class: 3.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

F. Elbow Configuration:

1. Rectangular Duct: 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."
2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
 - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 1. Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1,000 fpm or Lower: 90-degree tap.

- b. Velocity 1,000 to 1,500 fpm: Conical tap.
- c. Velocity 1,500 fpm or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Back-draft dampers.
 - 2. Combination fire-and-smoke dampers.
 - 3. Duct access doors.
 - 4. Fire dampers.
 - 5. Smoke dampers.
 - 6. Volume control dampers.
 - 7. Flexible duct connections
 - 8. Duct Taps
 - 9. Duct test holes
 - 10. Flexible duct elbow supports
- B. Related Sections:
 - 1. Section 23 31 00 - HVAC Duct and Casings: Requirements for duct construction and pressure classifications.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.
- C. Product Data: Submit data for shop fabricated assemblies including fire dampers including locations and ratings, smoke dampers including locations and ratings, backdraft dampers, flexible duct connections, volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit for Fire, Smoke and Combination Fire/Smoke Dampers.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

1.6 COORDINATION

- A. Coordinate Work where appropriate with building control Work.
- B. Coordinate fire alarm wiring requirements with Division 26.

1.7 WARRANTY

- A. Furnish five (5) year manufacturer warranty for duct accessories.

1.8 EXTRA MATERIALS

- A. Furnish two (2) of each size and type of fusible link for fire rated dampers.

PART 2 - PRODUCTS

2.1 BACK-DRAFT DAMPERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Arrow United Industries
 - 2. American Warming and Ventilating
 - 3. Ruskin
 - 4. Air Balance
 - 5. NCA
 - 6. Pottorff
 - 7. Greenheck
- B. Product Description: Multi-Blade, back-draft dampers: Parallel-action, gravity-balanced, Galvanized 16 gage thick steel, or extruded aluminum. Blades, maximum 6-inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.2 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff
 - 6. Greenheck
- B. Fabricate in accordance with NFPA 90A, UL 555, and UL 555S. Dampers shall be Leakage Class 1. Damper shall include a factory installed sleeve.
- C. Construction: Fabricate with 16 gage roll formed, galvanized steel hat-shaped channel frame. Furnish stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, concealed linkage, and 1/2-inch actuator shaft. Blades shall be airfoil type, 14-gauge equivalent. Blade edge seals shall be mechanically fastened to blade.

- D. Operators: UL listed and labeled two-position, fail close, electric type suitable for 120 volts, single phase, 60 Hz. Furnish end switches to indicate damper position. Locate damper operator on exterior of sleeve and link to damper operating shaft.
- E. Temperature rating: 250°F.
- F. Normally Closed Smoke Responsive Fire Dampers: Curtain type, opening by gravity upon actuation of Electro thermal link, flexible stainless-steel blade edge seals to produce constant sealing pressure.
- G. Coordinate fire alarm control wiring with Division 26.
- H. Rating: 1-1/2 hours in wall rated at less than three (3) hours.
- I. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of Electro thermal link, flexible stainless-steel blade edge seals to produce constant sealing pressure, stainless steel springs with locking devices to maintain positive closure for units mounted horizontally.
- J. Electric Fuse Link: Heat actuated, quick detecting to release at 165 degrees Fahrenheit, UL listed and labeled. Controlled closing and locking of damper in 7-15 seconds to allow duct pressure to equalize. Instantaneous closure is not acceptable. Manual reset at damper.

2.3 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1-inch-thick insulation with sheet metal cover.
 - 1. Less Than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches Square: Furnish two hinges and two (2) sash locks.
 - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside handles.
 - 4. Larger Sizes: Furnish additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.4 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff

- 6. Greenheck
- B. Fabricate in accordance with NFPA 90A and UL 555, and manufacturer's condition of listing. Permanently mark dampers for use in dynamic systems.
- C. Ceiling Fire Dampers: Galvanized steel, 24 gage frame and 24 gage blades with UL classified insulation if required. Provide with radiation blanket.
- D. Curtain Type Dampers: 20 gage Galvanized steel frame with interlocking 24 gage galvanized steel blades. Furnish stainless steel closure springs and latches for horizontal installations and closure under airflow conditions. Configure with blades out of air stream.
- E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless-steel sleeve bearings and plated steel axles, 1/8 x 1/2-inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- F. Fusible Links: UL 33, separate at 165 degrees Fahrenheit.
- G. Rating: 1-1/2 hours in wall rated at less than three (3) hours.

2.5 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Cesco
 - 2. NCA
 - 3. Ruskin
 - 4. Nailor
 - 5. Pottorff
 - 6. Greenheck
- B. Fabricate in accordance with UL 555S, Leakage Class I.
- C. Construction: Fabricate with 16 gage roll formed, galvanized steel hat-shaped channel frame. Furnish self-lubricating stainless-steel sleeve bearings and plated steel axles, stainless steel jamb seals, concealed linkage and 1/2-inch actuator shaft. Blades shall be airfoil type, 14-gauge equivalent. Blade edge seals shall be mechanically fastened to blade.
- D. Operators: UL listed and labeled two-position, fail close, electric type suitable for 120 volts, single phase, 60 Hz. Furnish end switches to indicate damper position. Actuator to be mounted internally or externally as required.
- E. Temperature rating: 250°F.
- F. Coordinate fire alarm control wiring with Division 26.

2.6 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
 2. Blade: Fabricate of single thickness sheet metal secured with continuous hinge or rod with end bearings.
 3. Operator: Minimum 1/4-inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- C. Single Blade Dampers: Fabricate for duct height up to 12".
- D. Multi-Blade Damper: Opposed blade interlocking type pattern for duct height 12" and greater. Assemble blades in galvanized frame channel with suitable hardware and linkage concealed in frame. Provide multiple section dampers for sizes larger than 48-inch x 72 inch. Provide jack shafting configuration and crossovers.
- E. Damper Blades:
1. Provide 16-gauge galvanized steel center and edge grooved blade type where velocities do not exceed 1500 FPM.
 2. Provide 14 gage galvanized steel. Roll formed airfoil blade type where velocities exceed 1500 FPM.
 3. Maximum leakage shall be 8 CFM per square foot of damper area at four (4) inches wg pressure.
- F. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or bronze bearings. Furnish closed end bearings on ducts having pressure classification over two (2) inches wg.
- G. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers that do not have actuators.
 2. On insulated ducts mount quadrant regulators on 2" standoff mounting brackets, bases, or adapters.
 3. Where rod lengths exceed 30 inches furnish regulator at both ends.
 4. Provide remote damper operators for concealed dampers. Operator shall utilize miter gears, worm gears and couplings or be cable operated. Coordinate operator trim and location with Architect / Engineer.
- H. Actuators:
1. Maximum damper area per actuator shall be 24 square feet face area.
 2. Actuators shall be two position or modulating spring return type.
 3. Duct mounted dampers shall have actuators mounted outside of air stream.
 4. Coordinate with Section 23 09 23 – Direct-Digital Control System for HVAC.

2.7 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 - 2. Net Fabric Width: Approximately six (6) inches wide.
 - 3. Metal: Three (3) inch wide, galvanized steel. Same gage as connecting duct.
 - 4. Install flexible connections with a minimum of one (1) inch between metal edges.
 - 5. Provide flexible duct connections at every duct connection to equipment.
- C. Application:
 - 1. Flexible duct connectors are not permitted on duct connections to internally isolated equipment. Internal isolation shall be in accordance with Section 230548.

2.8 DUCT TAPS

- A. Provide 24-gauge galvanized steel conical fittings with integral balancing damper for duct taps serving single ceiling diffuser. Balancing damper shall consist of 24 gauge, 3/8" steel axel and nylon end bearings with 2" standoff quadrant mount.
- B. Provide 24-gauge galvanized steel 45 degree, rectangular to round, side takeoff fitting with integral balancing damper when airflow is less than or equal to 20 percent of main duct airflow. Balancing damper shall consist of 24 gauge, 3/8" steel axel and nylon end bearings with 2" standoff quadrant mount.
- C. Provide tee split with radius elbow when takeoff or branch duct airflow is greater than 20 percent of main duct. Square throat elbows are acceptable in areas of limited clearances. Provide splitter damper. Refer to Section 23 31 00 - HVAC Duct and Casings.
- D. Provide volume damper at all takeoffs in constant volume systems and at all takeoffs downstream of terminal units in variable volume systems.

2.9 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, airtight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.
- B. Coordinate test hole locations and requirements with TAB contractor. If additional test holes are required for TAB, contractor will provide at no additional cost.

2.10 FLEXIBLE DUCT ELBOW SUPPORTS

- A. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6" – 16". Elbow supports shall be UL listed for use in return air plenum spaces.
- B. Provide elbow supports at each diffuser connection.
- C. Manufactured by Thermaflex – FlexFlow Elbow

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.
- B. Verify ducts and equipment is ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 REPORTS

- A. Per NFPA 90A, all fire dampers, smoke dampers and fire/smoke dampers must be tested prior to occupancy and contractor shall provide written confirmation if the dampers are operating as required. Provide pass / fail report in excel spreadsheet. Include type of damper, damper manufacturer / model, actuator manufacturer / model, fusible link in the excel spreadsheet.
- B. Contractor to provide as-built drawings of location of all fire, smoke and fire/smoke dampers with appropriate label that matches the installation.
- C. Per NFPA 80, contractor shall test and inspect all dampers prior to one (1) year warranty period. All inspections, testing and maintenance of dampers must be documented, indicating the location of the damper, date(s) of inspection, name of inspector and deficiencies discovered. The document must have a space to indicate when and how the deficiencies were corrected. All documentation is expected to be maintained and made available for review by the AHJ.
- D. After first year, test and inspection frequency must be every 4 years.

3.3 INSTALLATION.

- A. Install in accordance with NFPA 90A and follow SMACNA HVAC Duct Construction Standards Metal and Flexible. Refer to Section 23 31 00 - HVAC Duct and Casings for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside if motorized dampers are not shown on plans.
- C. Install duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and as indicated on Drawings. Install at locations for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Install minimum 8 x 8-inch size for hand access, 18 x 18-inch

size for shoulder access, and as indicated on Drawings. Review locations prior to fabrication.

- D. Install temporary duct test holes required for testing and balancing purposes. Cut or drill in ducts. Cap with neoprene plugs, threaded plugs, threaded or twist-on metal caps.
- E. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, and breakaway duct connections.
- F. Install smoke dampers and combination fire and smoke dampers in accordance with NFPA 92A.
- G. Install volume dampers at points on supply, return, outside air and exhaust systems where branches extend from larger ducts. For air systems with common return air plenum provide volume dampers in both outside air and return air 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.
 - 3. Install stainless steel volume dampers in stainless steel ducts.
 - 4. Install aluminum volume dampers in natatoriums.

3.4 DEMONSTRATION

- A. Demonstrate re-setting of fire dampers, fire and smoke dampers and smoke dampers to Owner's representative.

END OF SECTION 23 33 00

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide complete, fully operational fans where indicated on Drawings.
- B. Section Includes:
 - 1. Upblast centrifugal roof fans
 - 2. Inline Fans
- C. Related Sections:
 - 1. Section 23 31 00 - HVAC Duct and Casings - Ducts: Product requirements for hangers for placement by this section.
 - 2. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
 - 3. Coordinate work in this Section with Division 7.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, and ductwork and accessory connections.
- C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics, and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705 and UL 762 for kitchen exhaust.
- D. Balance Quality: Conform to AMCA 204.

1.6 WARRANTY

- A. Furnish one (1) year manufacturer's warranty for fans. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or start up will not be acceptable.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Fans shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- D. Do not deliver Equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.

1.8 UNIT IDENTIFICATION REQUIREMENTS

- A. Furnish each fan with a durable, deep etched, .025" thick, factory installed aluminum identification plate, permanently mounted with the following information:
 - Unit identification as indicated within Contract Documents.
 - Serial Number.
 - Model Number.
 - Capacity (CFM) and static pressure (w.g.).
 - Motor Horsepower.
 - Fan RPM.
 - Unit Power Supply: Volts / PH / Amps.
 - Supply Fan Drive Type.
 - Sales Order #.
 - Date of unit manufactured.

PART 2 - PRODUCTS

2.1 UPBLAST CENTRIFUGAL ROOF FANS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
 - 1. Greenheck
 - 2. Cook
- B. Fan shall be a spun aluminum, roof mounted, belt driven or direct drive, upblast centrifugal ventilator. Coordinate drive with fan schedule on drawings.
- C. Fan shall be constructed in accordance with UL 705. Fan shall bear the AMCA certified ratings seal for air performance.
- D. Construction: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16-gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have sealed curb cap corners by continuous weld or application of butyl tape to inside of the curb cap for maximum leak protection. The windband shall have a rolled bead for added strength. A two-piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14-gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.
- E. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.
- F. Motor: Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.
- G. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- H. Drives: Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- I. Roof Curb: 12-inch-high of 18-gauge galvanized steel construction with continuously welded seams, built-in cant strips, 1-1/2-inch insulation, damper tray, hinged curb adapter for access to dampers, and factory installed nailer strip. Coordinate installation with Division 7.

J. Accessories:

1. Motorized damper in damper tray of roof curb. Actuator shall be same voltage as motor in fan. Damper shall energize fan through integral end switch. Damper shall be epoxy coated.
2. Disconnect Switch: Coordinate with Division 26. Provide factory wired disconnect switch on 120v motor only. Factory provided disconnect switches shall be rated for outdoor use. Three phase combination disconnect/starter shall be provided by Division 26.
3. Direct drive units shall be provided with motor speed control option.
4. Birdscreen: Stainless steel rigid wire to protect fan discharge from birds or small objects.

2.2 INLINE FANS

- A. Manufacturers: Subject to compliance with scheduled capacities and specification, provide products by the following manufacturers.
1. Greenheck
 2. Cook
- B. Fan shall be a duct mounted, centrifugal, belt driven or direct drive, inline type supply or exhaust ventilator.
- C. All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.
- D. Construction: The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars. Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
- E. Coating: For fans serving Natatoriums or corrosive environments provide epoxy coating on all inside and outside surfaces including fan wheel and pulley.
- F. Wheel: The fan wheels shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
- G. Motor: Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase, and enclosure. Motor Pulleys shall be adjustable for system balancing.
- H. Bearings: Precision ground and polished shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum catalogued operating speed.
- I. Belts & Drives: Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.

J. Accessories:

1. Disconnect Switch: Coordinate with Division 26. Provide factory wired disconnect switch on 120v motor only. Three phase combination disconnect/starter shall be provided by Division 26.
2. Gravity actuated back-draft damper with adjustable counterweight. Damper shall be epoxy coated.
3. Direct drive units shall be provided with motor speed control option.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2 by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify roof curbs are installed, and dimensions are as shown on shop drawings.

3.2 INSTALLATION

- A. Secure roof fans with cadmium plated steel lag screws to roof curb structure.
- B. Install power ventilators level and plumb.
- C. Install dampers in roof curb damper tray.
- D. Provide hinged curb adapter to permit access to dampers and duct connection.
- E. Install safety screen where inlet or outlet is exposed.
- F. Provide sheaves required for final air balance.
- G. Install units with clearances for service and maintenance.
- H. Label units according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 CLEANING

- A. Vacuum clean inside of fan cabinet.

3.4 DEMONSTRATION

- A. Demonstrate fan operation and maintenance procedures.

3.5 PROTECTION OF FINISHED WORK

- A. Do not operate fans until ductwork is clean, bearings are lubricated, and fan has been test run under observation.

END OF SECTION 23 34 00

EQUIPMENT SHALL BID AS AN ALTERNATE

SECTION 23 63 13 - AIR-COOLED REFRIGERANT CONDENSERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes refrigerant condenser package, charge of refrigerant and oil, controls and control connections, refrigerant piping and connections, motor starters, electrical power connections.
- B. Related Sections:
 - 1. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolation for placement by this section.
 - 2. Section 23 00 - Refrigerant Piping: Execution requirements for connection to refrigerant piping specified by this section.

1.3 PERFORMANCE REQUIREMENTS

- A. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90.1 when used in combination with compressors and evaporator coils.

1.4 ACTION SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Product Data: For each air-cooled refrigerant condenser. Include rated capacities, operating characteristics, furnished specialties, and accessories. Include equipment dimensions, weights, and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Shop Drawings: For air-cooled refrigerant condensers. Include plans, elevations, sections, details, and attachments to other work.
 - A. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - B. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

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1. Structural members to which air-cooled refrigerant condensers will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Evaporators.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-cooled refrigerant condensers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
1. Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and Startup."
 2. Applicable requirements in ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
- D. Unit shall be UL listed.
- E. All refrigerant pipes shall be copper and coated for corrosion prevention after assembly.
- F. Units shall have all major electrical components out of the air stream. Products with compressors, water heater and receivers in the air stream must designate their sensible cooling outputs as a result of the heat gain from these components.
- G. Units shall be completely factory assembled, wired, piped, and tested. All controls shall be factory adjusted and preset to the design conditions. Test report shall be available on request.
- H. Units shall have a microprocessor controller with unit mounted refrigerant pressure transducers, air pressure transducers across filters and coils, temperature sensors and an Ethernet connection for monitoring and control via the internet.
- I. Provide single point electrical connection.
- J. Refer to section 3.1 for Field-Commissioning by Manufacturer.

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1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
- C. Coordinate location of refrigerant piping and electrical rough-ins.

1.9 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience approved by manufacturer.
- B. Installing contractor must be a Certified VRF installer by the VRF manufacturer. Certificate must be included within submittal for review.
- C. Installing contractor shall include all costs associated with VRF manufacturers Advanced System commissioning to ensure 10-year warranty is provided.

1.2 COMMISSIONING (PERFORMED BY MANUFACTURER AND NOT THIRD PARTY)

- A. The equipment manufacturer shall be responsible for providing a complete equipment commissioning report which includes the following:
 - 1. Current Installation Training Certificate from the installing contractor.
 - 2. Pre-piping jobsite visit report.
 - 3. Final system layouts and line sizes based on actual line lengths.
 - 4. Post-piping inspection report.
 - 5. Vacuum verification report. (This must be witnessed by the equipment manufacturer).
 - 6. Warranty approval verification.
 - 7. Final reports shall be provided to owner/engineer on company letterhead.
- B. During submittal phase include a sample of all inspection reports as well as individual(s) who will be the responsible party conducting all field visits and submitting reports.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.
- B. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- C. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture,

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chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.

- D. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.
- E. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- F. Protect units from physical damage. Leave factory covers in place until startup of machine.

1.11 WARRANTY

- A. The equipment manufacturer shall provide a full machine parts, labor, and refrigerant warranty for period of (5) five years. An additional complete system parts and compressor only warranty shall be provided for years (6) six through (10) ten. **Warranty shall begin at Certificate of Substantial Completion;** warranty shall not begin at date of shipment or start-up. Provide manufacturer's warranty certificates as described below.
- B. In addition to full machine parts, labor and refrigerant, the Standard and Extended warranty shall include miscellaneous materials, travel time, incidental expenses, normal freight/shipping, refrigerant, oils, lubricants, belts, filters, insulation, and any expenses related to service calls required to correct warranty issues.
- C. The manufacturer shall provide factory certificates for each piece of equipment listing as a minimum the model, serial number, and warranty information as specified above. Payment to contractor may be held if warranty certificates are not provided in a timely manner.
- D. **All warranty work shall be performed by factory direct service technician. Warranty work shall not be performed by installing mechanical contractor.**

PART 2 - PRODUCTS

2.1 AIR-COOLED REFRIGERANT CONDENSERS

- A. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. **Refer to Specification 01 23 00 Alternates for acceptable manufacturers.**
 - 2. **All materials and labor costs to coordinate, receive, install and start-up the equipment per this specification for a complete and operational system shall be included in the Contractor's Base Bid.**

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B. Product Description:

1. Self-contained packaged, factory assembled, pre-wired unit, suitable for outdoor use consisting of casing, condensing coil and fans, compressors, and controls. Each unit shall consist of hermetic scroll compressor air-cooled condenser section.
2. Construction and Ratings: In accordance with ARI 210/240. Testing in accordance with ASHRAE 20.

2.2 UNIT IDENTIFICATION REQUIREMENTS

- A. Furnish each unit with a durable, deep etched, .025" thick, factory installed aluminum identification plate, permanently mounted with the following information:
- Unit identification as indicated within Contract Documents.
 - Serial Number.
 - Model Number.
 - Nominal tonnage.
 - Motor Horsepower.
 - Unit Power Supply: Volts / PH / Amps; MCA / MOCP
 - Refrigerant type.
 - Sales Order #.
 - Date of unit manufactured.

2.3 GENERAL

- A. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, and capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
- B. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
- C. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.
- D. The sound level shall not exceed 67 dB when tested in an anechoic chamber under ISO3745.
- E. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
- F. The unit shall incorporate an auto-charging feature. Systems not incorporating an auto-charging function shall provide detailed calculations of refrigerant amounts needed for the system as installed. These calculations shall be provided in equipment submittal. A factory trained technician shall field verify installation and confirm refrigerant calculations based on installed system.

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- G. The outdoor unit shall be modular in design and should allow for side-by-side installation with minimum spacing. See drawings for requirements.
- H. The following safety devices shall be included on the condensing unit, high pressure sensor and switch, control circuit fuses, crankcase heaters, fusible plug, low pressure sensor, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, and over current protection for the inverter and anti-recycling timers.
- I. To ensure the liquid refrigerant does not flash when supplying to the Air Handling Units, the circuit shall be provided with a sub-cooling feature.
- J. The system shall have Hi-POR (High Pressure Oil Return) to ensure a consistent film of oil on all moving compressor parts at low speed. Oil is returned through a separate oil injection pipe. The system shall have an oil level sensor in the compressor to provide direct oil level sensing and shall only initiate oil return cycle if the oil level is too low. Timed oil return operations or non-oil level sensing systems shall not be permitted.
- K. The outdoor unit shall be capable of heating operation at 5°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source (5° F cooling only, 14° F simultaneous heating and cooling).

2.4 HOUSING

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
- B. Mount starters, disconnects, and controls in weatherproof panel with full opening access doors. Furnish mechanical interlock to disconnect power when door is opened.
- C. Furnish removable access doors or panels with quick fasteners. Units over 25 tons shall be provided with piano hinges and quick fasteners.
- D. Furnish welded steel floor mounting stand and duct collars at coil inlet and fan outlet.

2.5 CONDENSER COILS

- A. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
- B. The fins shall be completely covered in dipped and baked epoxy or GoldFin coating. GoldFin is an acrylic and hydrophilic coating. Baked epoxy and Ultra Gold coating shall have a 1,000-hour salt rating per ASTM B117.
- C. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

2.6 COMPRESSOR

- A. The inverter scroll compressors shall be variable speed HSS (High Side Shell) controlled.
- B. Each inverter driven, HSS scroll compressor shall be capable of operating in a frequency range from 15 Hz to 150 Hz with control in 0.5 Hz increments.

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- C. Non-inverter driven compressors shall not be permitted.
- D. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
- E. The compressor shall have internal isolation to avoid the transmission of vibration.
- F. Cabinets sized 6, 8 and 10 ton shall have one compressor. 12- and 14-ton cabinets shall be equipped with two compressors. 16-42-ton units are comprised of 2 or 3 cabinets together.
- G. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function.

2.7 FANS AND MOTORS

- A. The condenser fan shall be made of ABS material to prevent corrosion.
- B. The condensing unit shall consist of one or more propeller type, direct-drive 350 or 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
- C. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure is available to accommodate field applied duct for indoor mounting of condensing units.
- D. The fan shall be a vertical discharge configuration with a nominal airflow maximum range of 6,700 CFM to 20,650 CFM dependent on model specified.
- E. Nominal sound pressure levels shall be as shown on equipment schedule.
- F. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
- G. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
- H. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from 3 steps as shown below.

2.8 CONTROLS

- A. Factory wired and mounted control panel, NEMA 3R, containing fan motor starters, fan cycling thermostats, head pressure controls, compressor interlock and control transformer.
- B. Furnish controls to permit operation down to 10 degrees Fahrenheit ambient temperature.
- C. Furnish thermostat to cycle fan motors in response to outdoor temperature.

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- D. Furnish head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
- E. Furnish solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
- F. Furnish electronic low ambient control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.
- G. Furnish following safety controls arranged so that operating anyone will shut down machine:
 - 1. High discharge pressure switch (manual reset).
 - 2. Low suction pressure switch (automatic reset).
 - 3. Oil pressure switch (manual reset).
 - 4. Provide a timed off cycle.

2.9 CONDENSING UNIT PERFORMANCE

- A. Provide equipment with capacity as scheduled on Drawings.

2.10 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics: Provide equipment with electrical characteristics as shown on Electrical Drawings.
- B. Disconnect Switch: Coordinate with Division 26, Electrical.

PART 3 – EXECUTION

3.1 INSTALLATION REQUIREMENTS

- A. The installing contractor must hold a current training certification from the equipment manufacturer to install and support the system being installed.
- B. Install in accordance with ARI 430.
- C. Install in accordance with ASHRAE 15.
- D. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.
- E. Install refrigerant piping from unit to condensing unit. Install refrigerant specialties specified in Section 23 23 00 - Refrigerant Piping.
- F. Install connection to electrical power wiring in accordance with Division 26.
- G. Insulate coil headers located outside airflow as specified for piping.
- H. Provide trapped condensation drain line routed to the nearest floor drain.

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3.2 REFRIGERANT LINE SET SYSTEM CHARGING

- A. Mechanical contractor shall charge system using the following procedure or based on manufacturers authorized recommendations; whichever is more stringent:
 - 1. Install core in filter dryer after leak test but before evacuation.
 - 2. Evacuate entire refrigerant system with a vacuum pump to 500 microns. When vacuum holds for a minimum of 24 hours, system is ready for charging.
 - 3. During excavation, apply heat to pockets, elbows, and low spots in piping.
 - 4. Break vacuum with refrigerant gas, allow pressure to build up to 2 psig.
 - 5. Charge system with a new filter-dryer core in charging line.
- B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, trouble shooting, servicing, and preventive maintenance of refrigerant piping valves and refrigerant piping specialties.
- C. Review data in Operating and Maintenance Manuals.
- D. Schedule training with Owner with at least seven (7) days advance notice.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Install units on vibration isolators on 4" tall concrete housekeeping pad. Refer to 23 05 29 Hangers and Supports for HVAC Piping and Equipment and 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. System will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

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3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
- B. Perform the following final checks before startup:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connection to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Perform cleaning and adjusting specified in this Section.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Furnish cooling season start-up and winter season shutdown service, for first year of operation. If initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

3.3 DEMONSTRATION AND TRAINING

- A. Demonstrate starting, maintenance, and operation of unit.
- B. Demonstrate low ambient operation during winter testing or service specified above.

3.4 CLEANING

- A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean condensing unit externally and internally to remove foreign material and construction dirt and dust. Clean condensing coils, condensing fans, frame, etc.
- B. **Prior to building occupation, contractor shall clean condenser coils free from dirt and debris.**

PART 4 – PERFORMANCE

4.1 OPERATING RANGE

- A. The operating range in cooling will be 14°F DB ~ 12°F DB.
- B. The operating range in heating will be -13°F WB – 61 WB.

4.2 REFRIGERANT PIPING

- A. Refrigerant piping shall be copper; refer to specification 23 23 00.
- B. The system shall be capable of refrigerant piping up to 656 actual feet or 738 equivalent feet from the outdoor unit to the furthest indoor unit, a total combined liquid line length of

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Alena Park Independent School District

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3,280 feet of piping between the condensing and fan coil units with 360 feet maximum vertical difference, without any oil traps.

END OF SECTION 23 63 13

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SECTION 23 73 13 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes modular factory fabricated air-handling units and accessories.
- B. Related Sections:
 - 1. Section 23 05 00 - Common Work Results for HVAC.
 - 2. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
 - 3. Section 23 07 16 - HVAC Equipment Insulation: Product requirements for insulation for placement by this section.
 - 4. Section 23 33 00 - Air Duct Accessories: Product requirements for flexible duct connections for placement by this section.
 - 5. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
 - 6. Section 23 05 14 - Variable Frequency Controllers.

1.3 SUBMITTALS

- A. Provide line-by-line specification review annotated to certify compliance or deviation.
- B. Provide line-by-line schedule notes review annotated to certify compliance or deviation.
- C. Provide Footprint Square Footage Discrepancy Chart in spreadsheet form. Clearly show the differences in height, length, and width between the submitted units and designed units per plans for each AHU with corresponding tag.
- D. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- E. Product Data, Submit the following:
 - 1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.

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2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity per ARI 260.
 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.
- F. Manufacturer's Installation Instructions: Submit.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.6 QUALIFICATIONS

- A. Installer: Company specializing in performing Work of this section with minimum three (3) years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be factory wrapped by the manufacturer prior to shipment to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation. Protection of the complete unit from rusting and water

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migration must be handled as best suits the circumstances. Store in a place protected from construction traffic and weather.

- A. All equipment shall remain in manufacturer's protective shipping wrap during construction. Openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.
- B. Contractor shall adequately protect equipment from damage after delivery to the project. Equipment shall be completely covered and secured with heavy tarpaulins, drop cloths or other protective coverings as required to protect from inclement weather, moisture, chemicals, construction traffic, plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion. Protective covering is in addition to the manufacturer's original factory packaging. Original factory packaging shall not be deemed as acceptable protection of equipment.
- C. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the contractor is obligated to furnish new equipment of like kind at no additional cost to the Owner. Limit shipment of bulk and multi-use materials to quantities needed for immediate installation.
- D. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- E. Protect units from physical damage. Leave factory covers in place until startup of machine.

1.8 WARRANTY

- A. Furnish one (1) year manufacturer parts and labor warranty for air handling units. Warranty shall begin from date of Certificate of Substantial Completion. Warranty start date from shipment or start up is not acceptable.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Spare materials shall be provided by equipment manufacturer and not by the installing mechanical contractor or "by others".
 - 1. Filters: Furnish three (3) sets for each unit. One set during construction, a new set of filters for Test and Balancing services, and final new set at substantial completion. Filters shall be protected with polyester fabric at all times during construction.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

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- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

- A. Manufacturers: Subject to compliance with scheduled efficiencies, capacities, and specification, provide products by the following manufacturers.
 - 1. **Refer to Specification 01 23 00 Alternates for acceptable manufacturers.**
 - 2. **All materials and labor costs to coordinate, receive, install and start-up the equipment per this specification for a complete and operational system shall be included in the Contractor's Base Bid.**
- B. All air handling units shall be of the same manufacturer and same model; mismatched manufacturer's will not be acceptable.
- C. Configuration: Coordinate with project plans and schedules.
- D. Performance Base: Sea level pressure or altitude.
- E. Fabrication: Conform to AMCA 99 and ARI 430. Units shall be factory assembled and ship in one piece where possible. Shipping splits are acceptable provided manufacturer includes gaskets and bolts.

2.2 SPECIAL PROJECT REQUIREMENTS: CONSTRUCTION

- A. In order to demonstrate energy compliance with 2015 IECC performance method; the project as specified and scheduled was energy modeled and complies. Alternate manufacturers are allowed but must not exceed maximum scheduled brake horsepower, efficiency, etc.
- B. Air handling units shall be constructed to fit scheduled maximum dimensions including factory built mixing boxes and must maintain minimum specified access sections as scheduled and shown on plans. Rotating units to different orientations other than what is drawn on plans will be unacceptable. If potentially submitted equipment shall exceed any scheduled dimension, manufacturer shall provide performance data and dimensional data for consulting engineer to review and determine if proposed unit will fit within allotted space and maintain all required maintenance clearance. Equipment with deviations to dimensions shall be submitted 10 days prior to bid date for review.
- C. Outside air / return air mixing boxes shall be factory fabricated with the same construction as the unit casing. Field supplied or installed mixing boxes are not acceptable. Dampers shall be factory installed on mixing box openings. Actuators shall be provided by the control's contractor. This applies to all the air handling units with energy recovery and any unit with outside and return air ducted to the plenum.

2.3 UNIT IDENTIFICATION REQUIREMENTS

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- A. Furnish each unit with a durable, deep etched, .025" thick, factory installed aluminum identification plate, permanently mounted with the following information:
- Project name and address.
 - Unit identification as indicated within Contract Documents.
 - Serial Number.
 - Model Number.
 - CFM.
 - Entering and leaving air temperature (DB/WB) (cooling and heating coil).
 - Entering and leaving water temperature (cooling and heating coil).
 - Cooling and heating coil flow rate (GPM).
 - Fan Motor Horsepower.
 - Blower est. ext. sp. (in. wg.).
 - Unit Power Supply: Volts / PH / Amps; MCA / MOCP
 - Sales Order #.
 - Date of unit manufactured.
- B. Custom label shall be provided by and installed at the factory. Label shall not be by a third party or contractor.

2.4 CASING

- A. Base rail shall be a minimum of 12-gauge or heavier G-90 galvanized steel and shall be a minimum of six (6) inches in height. Base assembly shall be thermally broken and insulated with a minimum of 2" thick, R-13 closed-cell sprayed foam. Assemble multiple sections that are shipped loose with gaskets, caulk, and bolts per the manufacturer's installation instructions.
- B. External Casing:
1. Galvanized Steel: 22-gauge G90 with expanded foam injected insulation.
- C. Internal Casing:
1. Standard Units:
 - a. Galvanized Steel: Solid 22-gauge G90. Provide 22-gauge perforated panels in fan section and discharge plenum.
 2. Outside Air Units (refer to equipment schedule) or any units with mixture of return air and outside air:
 - a. **Stainless Steel:** Solid 22-gauge G90. Provide 20-gauge perforated panels in fan section and discharge plenum.
- D. Casing shall be supported by free-standing 16-gauge G90 structural frame with removable panels. Framing members shall have thermal break and injected with expanded foam insulation. Structural integrity of frame shall not be affected by removing panels. Top, bottom, and side panels shall be of one-piece double-wall construction, formed and reinforced to provide a rigid assembly. All panels shall be completely gasketed at factory with a minimum 1/4-inch-thick x 3/4 inch wide closed-cell neoprene. Top and side panels shall be easily removable for service.

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- E. Insulation: Expanded Foam.
 - 1. 'K' (Ksi) factor at 75 degrees Fahrenheit: Maximum 0.154 Btuh inch / sq. ft. / degrees Fahrenheit.
 - 2. Density: Two (2) inch thick, minimum 1-1/2 lbs. /cu ft. throughout the entire unit. One (1) inch thick casing panels in any section is unacceptable.
 - 3. Insulation in perforated sections shall be coated on air side to prevent erosion into air stream. Uncoated insulation is unacceptable.
 - 4. If air unit structural frame comes into contact with conditioned air, it shall be insulated with the same material throughout the rest of the unit.
- F. Access Section: Minimum 24" access section with minimum 19" door clearance of double wall galvanized steel construction for flush mounting, with gasket, latch, and handle assembly, same thickness as casing. Access door frame shall be extruded aluminum; foam filled with a thermal break barrier and include a full perimeter gasket. All access doors shall match unit casing construction, include a thermal break. Provide access section between parallel coil sections, upstream of coil sections, upstream and downstream of the energy recovery wheels, in fan sections, filter sections, and mixing boxes.
- G. Cooling Coil Drain Pan: Welded double wall, type 304 stainless steel IAQ pan with two (2) inch insulation and welded corners. Drain pans without welded corners are not acceptable. Cross break and pitch to drain connection. Cooling coils with a finned height greater than 48 inches shall have an intermediate stainless steel IAQ drain pan extending entire length of coil. Intermediate pan shall have a minimum of two drop tubes to main pan. Drain pans shall allow no standing water and comply with ASHRAE Standard 62. Drain pans must be accessible for cleaning.
- H. Strength: Furnish structure to brace casings for suction pressure of five (5) inch wg, with maximum deflection of 1 in 200. Casing deflection shall not exceed a L/240 ratio when subject to an internal pressure of +/- 8-in wg and shall exhibit no permanent deformation at +/- 9-in wg. L is defined as the longest linear panel or cabinet length (measured to AHRI 1350 Cd Level 2).

2.5 FANS

- A. Type: Refer to Air Handling Unit Schedule for fan type and drive type.
 - 1. Supply Fans:
 - a. Direct drive plenum fans shall be single width single inlet type with backward inclined airfoil blades. Plenum fan wheel, airfoil blades and hub shall be constructed from aluminum.
- B. Fan shall be statically and dynamically balanced at the factory as a complete fan assembly.
- C. The Fan wheels shall be keyed to shaft to prevent slipping.

EQUIPMENT SHALL BID AS AN ALTERNATE

- D. Construction: AMCA Class II minimum.
- E. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
- F. Sound Ratings: Tested to ARI 260 and label with Certified Sound Rating Seal.
- G. Bearings: Provide permanently lubricated bearings.
- H. Mounting: Locate fan and motor internally on welded or bolted steel base coated with corrosion resistant paint or rust-resistant G90 steel and factory-mounted motor on slide rails. Furnish access to motor, drive, and bearings through hinged access doors. Mount base on vibration isolators with 2" deflection.
- I. Fan Modulation: Variable frequency drive.
- J. Fan Motors: All motors shall be premium efficiency, NEMA MG-1 Section 3, Inverter Duty. Refer to Specification 23 05 13 - Common Motor Requirements for HVAC Equipment for acceptable motor manufacturers.
- K. Flexible Connection: Provide internal flexible connection between fan and air unit casing. Flexible connection between air unit casing and connecting duct shall not be provided when fan is internally isolated with flexible connection to casing.

2.6 BEARINGS AND DRIVES

- A. Bearings:
 - 1. Plenum fans shall have. Heavy duty pillow block style, self-aligning, regreasable roller type bearings selected for a minimum average life (L50) of 500,000 hours.
- B. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated to prevent corrosion.
- C. Motor Shaft Grounding Kit: For all AHU motors, a motor shaft grounding kit shall be provided. This shall be factory installed prior to shipment. If not available from the factory, the manufacturer is responsible for providing kits and field installation with no additional cost to owner or contractor.
- D. Motor: Motor shall be non-overloading. Motor horsepower shall be sized at a point on fan curve resulting from 105 percent of design RPM at scheduled CFM with a reduction in static pressure of 0.5-inch wg. All fan motors shall be in accordance with Section 23 05 13 - Common Motor Requirements for HVAC Equipment
 - 1. Motor Enclosure: Totally Enclosed Fan-Cooled (TEFC); ECM motors shall not be acceptable.
 - 2. Provide (2) two forged motor lifting eyes and oversized conduit boxes with ground lugs.
 - 3. 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.

EQUIPMENT SHALL BID AS AN ALTERNATE

4. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified

2.7 COILS

- A. Provide access doors upstream and downstream of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank-offs and casing sealing grommets at connection penetrations. Coils shall be supported by stainless steel coil support members maintaining a minimum of 1" separation between bottom of coil casing and drain pan. For AHU-09 & AHU-10, access can be downstream of both the heating and cooling coils, with no access in between.
- B. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- C. Water Heating Coils:
 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
 3. 18-inch access section between parallel coil faces. This requirement does not apply to AHU-09 & AHU-10.
 4. Casing: Die formed channel frame of galvanized steel.
 5. Tubes: 5/8-inch OD seamless copper, 0.020" thick, expanded into fins, brazed joints or 1/2-inch OD seamless copper, 0.025" thick, expanded into fins, brazed joints.
 6. Fins: Aluminum, maximum of 11 fins per inch. Minimum fin thickness shall be 0.006" aluminum.
 7. Coils with untreated outside air and mixed air (combination untreated outside air and return air) shall have a factory applied, flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 3,000 hours salt spray per ASTM B117-90. Field applied coatings will not be acceptable.
- D. Water Cooling Coils:
 1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.
 3. Coils shall be a maximum of eight (8) rows deep.

EQUIPMENT SHALL BID AS AN ALTERNATE

4. 18-inch access section between parallel coil faces. This requirement does not apply to AHU-09 & AHU-10.
5. Casing: Die formed channel frame of 16-gauge type 304 stainless steel.
6. Drain Pans: Extend 12 inches downstream of coil and for coil banks more than 48 inches high provide intermediate pan with down spouts.
7. Tubes: 5/8-inch OD seamless copper, 0.020" thick, expanded into fins, brazed joints or 1/2-inch OD seamless copper, 0.025" thick, expanded into fins, brazed joints.
8. Fins: Aluminum, maximum of 11 fins per inch. Minimum fin thickness shall be 0.006" aluminum
9. Coil supports shall be 16-gauge type 304 stainless steel.
10. Coils with untreated outside air and mixed air (combination untreated outside air and return air) shall have a factory applied, flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion durability shall be confirmed through testing to no less than 3,000 hours salt spray per ASTM B117-90. Field applied coatings will not be acceptable.

E. DX Cooling Coils:

1. Headers: Seamless copper tube with brazed joints.
2. Coils shall be a maximum of eight (8) rows deep.
3. 18-inch access section between parallel coil faces.
4. Casing: Die formed channel frame of 16-gauge type 304 stainless steel.
5. Drain Pans: Extend 12 inches downstream of coil and for coil banks more than 48 inches high provide intermediate pan with down spouts.
6. Tubes: 5/8-inch OD seamless copper, 0.020" thick, expanded into fins, brazed joints or 1/2-inch OD seamless copper, 0.025" thick, expanded into fins, brazed joints.
7. Fins: Aluminum, maximum of 11 fins per inch. Minimum fin thickness shall be 0.006" aluminum.
8. Coil supports shall be 16-gauge type 304 stainless steel.
9. Coils with untreated outside air and mixed air (combination untreated outside air and return air) shall have a factory applied, flexible, epoxy polymer e-coat uniformly applied to all coil surface areas without material bridging between fins. Humidity and water immersion resistance shall be up to a minimum 1,000 and 250 hours respectively (ASTM D2247-92 and ASTM D870-92). Corrosion

EQUIPMENT SHALL BID AS AN ALTERNATE

durability shall be confirmed through testing to no less than 3,000 hours salt spray per ASTM B117-90. Field applied coatings will not be acceptable.

- F. Tube Velocities: Coil tube design velocity shall be between 2 feet and 5 feet per second and also maintain design water side temperature difference down to 30 percent flow through coil. Provide tubes that are enhanced internally if minimum initial design tube velocity cannot be obtained.

2.8 GERMICIDAL UVC EMITTERS - REQUIRED

Provide adequate space in the cooling coil section to allow for UVC Emitter installation and wiring and allow for a minimum 18" access door. Maintain full service; UVC Emitters to be provided in future.

UVC Emitters shall be provided by the air handling unit manufacturer for field installation by the mechanical contractor.

- A. UVC Emitters shall be provided for each Air Handling Unit and manufactured by Steril-Aire, Inc. only. UVC lights, including but not limited to safety switches and non-fused service disconnects, shall be field installed by local Steril-Aire factory authorized representative and not by mechanical contractor. A separate 120v/1ph electrical connection shall be provided by the electrical contractor.
- B. Provide UVC Emitter in the same section as cooling coil immediately downstream of cooling coils and over drain pans; lights shall provide full coverage of cooling coils and drain pan. The UVC emitter shall be mounted inside the air handler casing a minimum of 12" downstream of cooling coil.
- C. UVC Emitter and fixture shall be factory assembled and tested. Unit shall consist of housing, power source, reflector, emitter sockets, emitter, door safety switches and unit mounted disconnect for separate 120v / 1ph / 60 Hz power supply. Unit shall be constructed to withstand HVAC environments and shall be UL and CSA listed for damp locations.

Housing shall be constructed of hospital grade stainless steel and equipped with ½" conduit openings on each end to facilitate conduit nipple coupling fixture to fixture and wiring to power. Incorporate all components into one integral assembly that maximizes serviceability. Unit shall be designed to be mounted inside the air stream and downstream of the cooling coil.

The power source shall be a Class P2, rapid start type with a power factor of 0.99 and an efficiency of not less than 89%. Unit voltage shall be 120 and designed to maximize photon production, radiance, and reliability in cold or moving air streams of 35°-170°F. 100% RD and at any velocity and shall include RF and EMI suppression and Smart System – "End of Lamp Life" protection.

Reflector shall be constructed of heavy gauge aluminum alloy with a minimum 86% reflectance at 254 nm.

Sockets shall be medium bi-pin, double click safety, and twist lock type. They are constructed of a UVC resistant polycarbonate.

Emitter tube shall be high output, hot cathode, T5 diameter, medium bi-pin type that produces broadband UVC of 250 – 260 nm. Each tube shall produce the specified output

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at any airflow velocity and air temperature of 35°-170°F and produce no ozone or other secondary contamination.

Independent testing: When tested in accordance with the general provisions of IES Lighting Handbook, 1981 Application volume, output per 1" arc length is not less than 10μW/cm² at 1 meter in a 400-fpm airstream of 45° F.

2.9 OUTSIDE AIR DAMPERS (REQUIRED FOR ALL OUTSIDE AIR UNITS AND UNITS WITH MIXING SECTIONS)

- A. Outside Air Damper Assembly: Unit shall have a factory installed motor operated outside air damper assembly constructed of stainless steel, hollow core, airfoil blades with rubber edge and end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq. ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return, fully modulating actuator. Electronic actuators shall be provided and installed by Building Automation Systems subcontractor.
- B. Damper blades shall be gear driven and designed to meet smoke damper Class-1 leakage specifications in accordance with U.L. 555S at 4 inches w.g. air pressure differential across the damper.
- C. Damper assembly shall be controlled by spring return, modulating actuator.
- D. Once set, outdoor air dampers shall open to the minimum set position when indoor fan starts. The damper shall close to the full closed position when indoor fan shuts down.
- E. Demand Control Ventilation: Provide a factory installed and wired return air CO2 sensor to override the damper actuator to provide more outside air.
- F. Bird Screen: Provide 1-inch aluminum mesh pre filter upstream of the outside air opening.
- G. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.10 AIR FILTRATION

- A. Filter Box: A six-inch bolt-on filter rack shall be provided and field installed on the return air portion of the unit. Filter racks shall accommodate slide in-filters of standard sizes.
- B. Replaceable Filters: MERV 11 or greater rating in accordance with ASHREA Test Standard 52.2-2007.
- C. Bolt-on flat filter rack shall be provided and field installed.
- D. Provide list of each air handling unit with associated filter sizes to owner at substantial completion.

2.11 CONTROLS

- A. Controls: Refer to Section 23 09 23 - Direct-Digital Control System for HVAC.

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2.12 CAPACITY

- A. Performance: Provide equipment as scheduled on Drawings.

2.13 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Provide equipment with electrical characteristics as shown on Electrical Drawings.
- B. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Requirements for motors.
- C. Section 23 05 14 - Variable Frequency Controllers: Requirements for drives.
- D. Combination Starter-Disconnect Switch: Provided by Division 26.
- E. Junction Box: Factory provided, mounted, and wired junction boxes on each fan section. J-box shall allow electrical contractor to connect power to device without penetrating through cabinet. Field installed J-boxes will not be acceptable; it shall be the complete responsibility of the manufacturer to install. Units shall be shipped with J-boxes pre-wired and mounted. Within equipment submittal the manufacturer shall show J-box location on plan view dimensional drawing.
- F. Motor Overload Panel: For units with more than one fan, and to allow for a connection to a single variable frequency drive, provide a factory mounted and wired motor overload panel. Panel shall be UL listed, NEMA 1 enclosure with IECC manual starters with rotary type operators and auxiliary contacts.
- G. All starters shall be equipped with integral phase-failure relay (automatic resetting type) to shut down motor upon loss of an electrical phase.

2.14 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
- D. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with ARI 430.

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- B. The mechanical rooms shall be kept broom clean prior to starting any mechanical equipment to minimize dust in the system.
- C. Install assembled units with internal vibration isolators. Internally isolated fans shall be provided with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating. Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- D. Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases. Comply with requirements for concrete bases; Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Contractor to provide fixed sheaves required for final air balance as dictated by Test and Balance Contractor.
- F. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- G. Insulate coil headers located outside airflow as specified for piping. Refer to Section 23 07 19 - HVAC Piping Insulation.
- H. Provide trapped condensation drain line routed to the nearest floor drain. Refer to detail on Drawings and Section 23 21 13 - Hydronic Piping.
- I. Installation of Hot Water Heating and/or Chilled Water Coil:
 - 1. Make connections to coils with unions. Position unions to permit coil removal.
 - 2. Connect water supply to leaving airside of coil (counter flow arrangement).
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Install water coils to allow draining and install drain connection at low points.
 - 5. Install the following piping accessories on piping connections. Refer to Section 23 21 13 - Hydronic Piping.
 - a. On supply: (refer to coil connection details)
 - 1) Thermometer well and thermometer.
 - 2) Well for control system temperature sensor.
 - 3) Shutoff valve.
 - 4) Pressure gage.
 - 5) Strainer
 - b. On return: (refer to coil connection details)
 - 1) Air vent.
 - 2) Thermometer well and thermometer.
 - 3) Well for control system temperature sensor.
 - 4) Pressure gage.
 - 5) Modulating control valve (by BAS).

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- 6) Victaulic / TA 78K (combination balancing / shut-off globe valve with memory stop and pressure / temperature ports).
- 7) Shutoff valve (provided by mechanical contractor in addition to balancing valve).
- 6. Install valves and piping specialties in accordance with details as indicated on Drawings.
- 7. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13 - Hydronic Piping.
- 8. Install floor support stands at piping drops to air unit coil connections. Air unit coil shall not carry any suspended piping load.
- J. Air unit manufacturer representative shall remove vibration isolation shipping blocks prior to start-up and ensure that fan base is free floating, and isolators are not short-circuited during operation.

3.2 CONNECTIONS

- A. Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
- B. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Install piping adjacent to air-handling unit to allow service and maintenance.
- D. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- E. Refrigerant Piping: Comply with applicable requirements in Section 23 23 00 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
- F. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 23 31 13 "Metal Ducts" and Section 23 33 00 "Air Duct Accessories."
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 23 33 00 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.

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1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 2. Charge refrigerant coils with refrigerant and test for leaks.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.4 STARTUP SERVICE

- A. Perform startup service.
1. Complete installation and startup checks according to 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, 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 zone dampers fully open and close for each zone.
 7. Verify that outdoor- and return-air mixing dampers open and close and maintain minimum outdoor-air setting.
 8. Comb coil fins for parallel orientation.
 9. Verify that proper thermal-overload protection is installed for electric coils.
 10. Install new, clean filters.
 11. Verify that manual and 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.

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3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.5 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.

3.6 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units externally and internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, comb coils, drain pans, and filter housings, and install new, clean filters.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

3.8 PROTECTION OF FINISHED WORK

- A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- B. All air units shall remain in manufacturer's protective shipping wrap during construction. Air unit casing openings must remain protected and covered during construction. If protective wrap has been damaged, the contractor shall provide additional protective wrap as directed by engineer.

END OF SECTION 23 73 13

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SECTION 23 81 26 - DUCTLESS MINI-SPLIT-SYSTEM AIR-CONDITIONERS

PART I -GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL REQUIREMENTS

- A. Indoor, wall or ceiling mounted, direct-expansion fan coils are matched with cooling only outdoor unit.
- B. Outdoor air-cooled split system compressor sections suitable for on-the-ground, rooftop, wall hung or balcony mounting. Units shall consist of a rotary compressor, an air-cooled coil, propeller-type draw-through outdoor fan, metering device(s), and control box. Units shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to-air cooling only or heat pump system (refer to schedule).
- C. Indoor unit shall be rated per ARI Standards 210/240 and listed in the ARI directory as a matched system.
- D. A factory provided and installed BACnet communication interface card with building automation system shall enable building automation system operator to remotely control and monitor the system from an operator workstation. Control features available, and monitoring points displayed locally at fan coil controller shall be available through building automation system.
- E. Outdoor unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with the NEC. Units shall be evaluated in accordance with UL standard 1995. Units shall be listed in the CEC directory. Unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061). Air-cooled condenser coils shall be leak tested at 573 psig.
- F. Provide equipment with electrical characteristics as shown on the Electrical Drawings.

1.3 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with plans and specification, provide one of the following:
 - 1. **Refer to Specification 01 23 00 Alternates for acceptable manufacturers.**
 - 2. **All materials and labor costs to coordinate, receive, install and start-up the equipment per this specification for a complete and operational system shall be included in the Contractor's Base Bid.**

1.4 SUBMITTAL:

- A. Submit in form similar to the schedule on the Drawings. Show all data listed in schedule, electrical characteristics and accessories being provided.

DUCTLESS MINI-SPLIT-SYSTEM AIR-CONDITIONERS

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- B. Provide line-by-line specification review annotated to certify compliance or deviation.
- C. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.
- D. Product Data: Submit product data, including manufacturer's □ product sheet for specified products.

1.5 WARRANTY

- A. One (1) year on unit parts other than compressor/motor assembly. Warranty shall begin from date of Certificate of Substantial Completion.
- B. Five (5) years on compressor/motor assembly. Warranty shall begin from date of Certificate of Substantial Completion.
- C. One (1) year on refrigerant and oil. Warranty shall begin from date of Certificate of Substantial Completion.

PART 2 –PRODUCTS

2.1 UNIT CABINET:

- A. Indoor unit cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
- B. Outdoor unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish on inside and outside. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
- C. Indoor and outdoor unit shall be of the same manufacturer.

2.2 COMPRESSOR

- A. Compressor shall be fully hermetic rotary type. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from over-temperature and over-current. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere. Compressor assembly shall be installed on rubber vibration isolators.

2.3 COIL

- A. Evaporator coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap.
- B. Condenser coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.

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2.4 FANS

- A. Fan shall be tangential direct-drive blower type with air intake at the top of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard. Air sweep operation shall be user selectable. The vertical sweep may be adjusted (using the remote control) and the horizontal air direction may be set manually.

2.5 AIR FILTERS

- A. Unit shall have filter track with factory-supplied cleanable filters.

2.6 BUILDING AUTOMATION SYSTEM INTERFACE:

- A. Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 62° F to 84°F.
- B. The unit shall have integral controls provided by unit manufacturer to perform input functions necessary to operate the system. Factory installed hardware and software to enable building automation system to monitor, control, and display status and alarms.
 - 1. A factory provided and installed BACnet communication interface card with building automation system shall enable building automation system operator to remotely control and monitor the system from an operator workstation. Control features available, and monitoring points displayed locally at fan coil controller shall be available through building automation system.
 - 2. The unit shall be compatible with interfacing with connection to BACnet networks or interfacing with connection to BMS system.
- C. The unit shall have the following functions as a minimum:
 - 1. An automatic restart after power failure at the same operating conditions as at failure.
 - 2. A timer function to provide a minimum 24-hour timer cycle for system Auto Start/Stop.
 - 3. Temperature-sensing controls shall sense return air temperature.
 - 4. Indoor coil freeze protection.
 - 5. Wireless infrared remote control to enter set points and operating conditions.
 - 6. Automatic air sweep control to provide on or off activation of air sweep louvers.
 - 7. Dehumidification mode shall provide increased latent removal capability by modulating system operation and set point temperature.

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8. Fan-only operation to provide room air circulation when no cooling is required.
9. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit.
10. Fan speed control shall be user-selectable: high, medium, low, or microprocessor controlled automatic operation during all operating modes.
11. Automatic heating-to-cooling changeover in heat pump mode. Control shall include dead band to prevent rapid mode cycling between heating and cooling.
12. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.

PART 3 -EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 1. Leak Test: After installation, fill water coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
 2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

3.2 STARTUP SERVICE

- A. Refer to Section 23 05 93 Testing, Adjusting, and Balancing for HVAC.

3.3 CLEANING

- A. Clean units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
- B. After completing system installation and testing, adjusting, and balancing fan coil and air-distribution systems clean filter housings and install new filters.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 23 81 26

SECTION 23 90 00 - REFRIGERANT DETECTION MONITORING SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract and the requirements of Section 15050 apply to the work specified in this Section.

1.2 SUBMITTALS

- A. Provide Monitor Panels as required to provide function in this specification and as shown on drawings.
- B. Provide panels with electrical characteristics shown on the electrical drawings.
- C. Refrigerant Monitor shall be third party validated to UL61010.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Submit instructions for operation, replacement parts, spare parts list, and wiring diagrams.

1.4 ACCEPTABLE MANUFACTURERS

- A. International Gas Detectors Tocsin controller & detector range
- B. Honeywell / Vulcain

PART 2 – PRODUCTS

2.1 REFRIGERANT GAS MONITORING PANEL

- A. Provide a refrigerant gas detection system designed to measure the level of multiple refrigerant gas compounds in multiple monitoring areas. The system should consist of a central controller interconnecting with field mounted gas detectors of Infra-Red or Characterized Semi-conductor technology. Interconnection between controller and field devices should be through a 2-core addressable multi drop highways depending on detector numbers and locations relative to controller. Detectors being mounted to best cover risk area according to current manufacturers and industry advice. Monitoring system shall support compliance with ASHRAE 15-1994.
 - 1. The gas detection system should be an addressable type interconnecting to all field devices on a 2-core screen multi-drop highway. Controller should have a minimum of a single highway expandable to 32 gas detectors.
 - 2. Addressable highway should have polarity independent cores utilizing Sentinel+ addressable protocol enabling simple and quick install without need for core identifications. Addressable highway should have a capacity of 32 detectors.
 - 3. The gas detection system shall automatically and continuously monitor for multiple refrigerant gases and compare concentrations to user-settable PPM limits per areas monitored for selected gas.
 - 4. Gas detection system to be capable of zoning alarm areas to enable Chiller Plant Room systems to be incorporated into locally fitted Heating Plant Room systems but provide independent alarms.
 - 5. The gas detection system shall be capable of being calibrated per application for the selected refrigerant gas per area monitored at the specified accuracy for each

refrigerant gas in PPM (parts per million) concentrations including: R-22, R-410a, R-123, R-134a, R-32, R-513A, R-514a, R-454B and other gases.

6. The gas detection system shall be capable of interconnecting with and monitoring infrared type or characterized semi-conductor technology with factory and field calibrated settings for selected refrigerants. Measurement range for each refrigerant gas with accuracy as a percentage of full scale in ambient temperature ranges of 32 to 122 degrees Fahrenheit and 5 percent to 90 percent ambient humidity (non-condensing).
7. The gas detection system controller shall have a minimum of:
 - a. Four (4) SPCO alarm contacts -three (3) are for alarm levels and one (1) for system fault.
 - b. Three (3) indicator lights:
 1. green "on" for normal operation
 2. red "on" for alarm
 3. yellow "on" for system fault
 - c. Modbus RS485 output for connection to external devices with full Modbus Map freely available for 3rd parties.
 - d. Alarm and fault log capability for. Minimum of 1,000 points.
7. All configuration and monitoring parameters on the gas detection controller may be accessed one or two ways concurrently:
 - a. Via web enabled devices accessing controllers on-board Wi-Fi pages; access must be Password protected.
 - b. Via Wi-Fi dongle connected onto detector (allowing access to all devices on highway); access must be password protected.
8. Three alarm levels shall be provided indicating three (3) independent "alarm" level conditions. Thresholds for all alarms are to be individually adjustable with a factory setting of 200 PPM for "Alarm 1", 300 PPM for "Alarm 2", and 400 PPM for "Alarm 3". To minimize false alarms, the unit's minimum/maximum alarm levels should be set at factory recommended settings in compliance with ASHRAE Safety Code 34-1992 allowable exposure limits.
9. System should be capable of operation even though a fault occurs. Controller should have a fault Indicator light and display should detail nature of the fault.
10. The gas detection system should have an electronics warranty of minimum 10 years; sensor warranties to reflect technologies utilized.
11. Periodic gas detection system bump testing, calibration and checking or adjustments shall be capable of being accomplished by one person. Gas detection system shall have a self-diagnostics and indication of diagnostic status. Diagnostics shall include the refrigerant sensor/s.
12. Installation of gas detection system should follow manufacturers installation recommendations (see IGD 2 Wire Installers Guide).

2.2 GAS DETECTION CONTROL PANEL

- A. The control panel should have an auto-setup function upon initiation. Upon first powering the device should ask for a FIND function that enables it to interrogate the connected highway, recognize and download details of all connected devices and automatically set channels and alarm points without any personnel interaction.
- B. The control panel provides remote programming, interrogation, and display functions to support the field mounted gas detectors. The system design supports compliance to the refrigerant monitoring requirements of ANSI/BSR ASHRAE 15-1994.
- C. The control panel accepts a minimum of 1 Sentinel+ addressable input capable of monitoring up to thirty-two (32) field mounted detectors.
- D. Gas detector readings should be updated a minimum of once per second.
- E. Back lit LCD – The “Display” mode will display the measured point in PPM. The display will show a green backlight to reflect a safe condition and the light ring around the controller jog wheel will also be backlit green.
- F. The control panel should have the ability to log a minimum of 1,000 events (alarms, resets, power activities etc.)
- G. Upon alarm, the channel display displays the channel in alarm (with live gas data), the backlit display changes from GREEN SAFE to RED , the light ring around the jog wheel changes from GREEN to RED, an internal 85dB sounder activates and the red alarm LED illuminates. Depending upon alarm Cause & Effect one or more of the SPCO, 230VAC 4Amp programmable relays change state.
- H. The LCD display indicates any input fault that may occur and identifies the fault area, upon FAULT the display will be backlit YELLOW, the light ring around the jog wheel changes from GREEN to YELLOW.
- I. The Control Panel shall provide Modbus RS485 to enable to operate in parallel with building management systems for the monitoring and interrogation of the control panel data.
- J. Control panel shall be able to “lock out” any instructions through the local keypad by password.
- K. Upon power failure, the control panel will have the capability to restart all individual monitors on the system. Upon return of electrical power, the control panel will be able to re-boot itself and return to operation without loss of programming or stored data (one month downtime without loss of data as a minimum).
- L. The control panel should be capable of operating devices up to 3000 feet from controller location dependent on cable core size and detector location.
- M. Two-way communication via Sentinel+ to a maximum of 32 detectors linked together in daisy-chain fashion is required. An onboard Wi-Fi port should enable password protected access by any web enabled device.
- N. The control panel shall have an operating temperature of 32° – 122°F.
- O. The control panel power consumption shall be less than 10 watts maximum 85-230VAC and be capable of running on 50 to 60 HZ power supply.
- P. There shall be four (4) relays in the monitor unit. Four (4) relays shall be available for customer connections. All relays shall be rated at 230VAC 4 AMP. Alarm relays shall be capable of being programmed within the gas detection range and options to be Rising or Falling, Latched alarms or Auto-reset, energized or none energized configurations.

1. ALARM 1: The Alarm relay connection shall be provided for the addition of an audible or visual warning device. This relay will energize in the event that an area for Alarm 1 level has been exceeded.
 2. ALARM 2: The Alarm relay connection shall be provided for the addition of an audible or visual warning device. This relay will "energize" in the event that an area for Alarm 2 level has been exceeded.
 3. ALARM 3: The Alarm relay connection shall be provided for the addition of an audible or visual warning device. This relay will "energize" in the event that an area for Alarm 3 level has been exceeded.
 4. FAULT: The Fault relay shall be a normally energized relay automatically changing state upon FAULT or Power Loss.
- O. Unit power consumption shall be less than 50 watts maximum, 230 volts AC and be capable of running on 60 Hz supply.
- P. Program access to be denied by password to prevent unauthorized personnel from accessing the device. Program will automatically reset to full function settings following power interruption.
- Q. Gas detection system to be capable of zoning alarm areas to enable Chiller Plant Room systems to be incorporated into locally fitted Heating Plant Room systems but provide independent alarms.
- R. Wiring connections shall be through 20mm electrical ports located on the bottom panel of the enclosure. Rear of control panel should be capable of being rotated to enable cable ports to be placed top or bottom. Rear panel knock outs should also be provided for cable entries.

2.3 GAS DETECTORS

- A. The gas detectors shall be either infrared type or characterized semi-conductor technology with factory and field calibrated settings for selected refrigerants.
- B. Gas detectors must be provided pre-calibrated and be able to interact with the control panel during its initial FIND operation to automatically set up the details of gas type, range, and alarm points.
- C. Gas detectors shall be 2 wire addressable technology compatible with Sentinel+ protocol and polarity independent connection.
- D. Gas detectors shall have inboard I/O to enable (as a minimum) a 24VDC beacon sounder to be connected locally (maximum rating 100mA). Beacon sounder functions to be split for independent beacon & sounder operation (muting etc.).
- E. Gas detectors to have an onboard Volt Free SPCO Relay rated 230VAC 4 Amp to enable local switching of plant (ventilation, chillers etc.).
- F. Gas detectors should have a "hot swappable" front that enables gas sensors to be exchanged at end of life, upgraded, or swapped to other technologies or gas types upon plant change requirements.
- G. Measurement range for each refrigerant gas with accuracy as a percentage of full scale in ambient temperature ranges of 32 to 122 degrees Fahrenheit and 5 percent to 90 percent ambient humidity (non-condensing).
- H. The gas detection system shall adhere to a temperature drift tolerance of 0.3 percent per degrees Celsius and have a sensitivity of 1 PPM (parts per million).
- I. Gas monitoring should be continuous.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install panels and all detectors as shown on the drawings. Sufficient clearances allow easy service, maintenance, and replacement components.
- B. Provide a combination strobe light and horn at each exit of refrigeration room (minimum two for room). The audible alarm shall be heard over the equipment room noise. The strobe light shall be energized when there is an alarm.
- C. Installation of gas detection system should follow manufacturers installation recommendations (see IGD 2 Wire Installers Guide).
- D. Demonstrate all functions of refrigerant monitoring system.
- E. Train the Owner on operations and maintenance of monitoring system.

3.2 SEQUENCE OF OPERATION

- A. Refrigerant detection system shall monitor the presence of refrigerant in the Central Plant. If refrigerant is detected, an automatic system of refrigerant evacuation will be initiated. The following sequence shall also be initiated from a manual switch located on the refrigerant detection system panel. The refrigerant detection system supplier shall provide a "dry" set of contacts, initiated automatically. On activation of the contacts, the following sequence shall occur.
 - 1. Exhaust fan (Refer to plans for tag) shall be energized to high speed.
 - 2. Supply Fans (Refer to plans for tag) shall be energized.
 - 3. BAS shall shut down all pumps and chillers.
 - 4. Provide an audible and visual alarm in the machine room with a silence switch and pilot light. Initiate the alarm and flash the light when the exposure limit is exceeded. After the audible is reset the pilot light shall remain illuminated until the alarm clears.
 - 5. Control sequence above shall be accomplished by hard wire interlocks.
 - 6. An alarm conditions shall be annunciated at the BAS when the refrigerant leak detection panel determines exposure limits have been exceeded.
- B. Refer to electrical drawings and specifications for "EVS" Emergency Ventilation Fan Switch and "ERS" Emergency Refrigeration Switch locations and operation.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstrate system operations and verify specified performance. A functional test of the installed system shall be performed to demonstrate proper functioning of all interlocks and protective systems specified or otherwise required. This testing shall be conducted in the presence of the Owner's representative and the Engineer. The Contractor shall submit test procedure for approval by the Engineer prior to testing.

END OF SECTION 23 90 00

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUBSTITUTIONS OF PRODUCTS

- A. The products described in the Proposal Documents establish a standard of required function, dimension, appearance and quality to be met by any proposed substitution. The materials and equipment named in, and the procedures covered by these specifications have been selected as a standard because of quality, particular suitability or record of satisfactory performance. It is not intended to preclude the use of equal or better materials or equipment provided they meet the requirements of the particular project and are approved in an Addendum as a substitution prior to the submission of proposals.
- B. No substitution will be considered prior to receipt of proposals unless written request for approval has been received by the Architect and Engineer at a minimum of seven (7) business days prior to the date for receipt of proposals. Each request shall provide the following
1. A specification line by line review annotated to certify compliance.
 2. The name of the manufacturer and model, material or equipment for which it is to be substituted
 3. A complete description of the proposed substitute including dimensional drawings, cutsheets, performance and test data and any other information necessary for an evaluation.

The Engineers decision of approval or disapproval of a proposed substitution shall be final.

- C. If the Engineer approves any proposed substitution prior to receipt of proposals, such approval will be set forth in an Addendum. Offerors shall not rely upon approvals made in any other manner.
- D. The Engineer and Owner reserve the right to reject the use of any manufacturer who in their judgment is unsuitable for use on the Project and that decision will be final.
- E. Availability of specified items:
1. Verify prior to submittal of Proposal that all specified items will be available intime for installation during orderly and timely progress of the work.
 2. In the event specified items will not be so available, notify the Architect / Engineer prior to receipt of Proposals. Submit Request for Substitutions in accordance with this section.
 3. The request will not be considered if the Contractor's failure to pursue the work promptly or coordinate activities properly results in the product or method not being provided.

4. Costs of delays because of non-availability of specified items, when such delays could have been avoided by the Contractor, will be back-charged as necessary and shall not be borne by the Owner.
- F. A request constitutes a representation that Offeror:
1. Has investigated the proposed product and determined that it meets or exceeds the quality level of specified product.
 2. The Substitution will be provide the same warranty as the specified product, except when inability to provide specified Warranty is the reason for request for substitution as described above.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 5. Will reimburse the Owner and pay for all costs, including Architect/Engineer's redesign and evaluation costs resulting from the use of the proposed substitution, or for review or redesign services associated with re-approval by authorities having jurisdiction.
- G. **No substitutions will be considered after the Award of Contract.**

1.3 SUMMARY

- A. All work for electrical systems as required in the project shall be properly installed and tested to perform their intended function.

1.4 QUALITY ASSURANCE

- A. Perform all work in accordance with the latest edition of the National Electrical Code, and local codes.
- B. All electrical materials and distribution, and utilization equipment shall be UL Listed.
- C. All equipment and materials shall be new and unused and of United States Domestic manufacture unless approved otherwise by engineer or owner.
- D. Eliminate any abnormal sources of noise that are considered by the architect not to be an inherent part of the electrical systems as designed.

1.5 COORDINATION WITH OTHER TRADES

- A. Coordinate the work of this division with all other divisions to ensure that all components of the electrical system shall be installed at the proper time and fit the available space.
- B. Locate and size all openings with the work of other trades as required for the proper installation of the electrical system components.
- C. Make all electrical connections to all equipment furnished by this division and any other division.

- D. Make all electrical connections from all 120 volt and greater dampers and switches to associated exhaust fan(s) furnished by any other division.

1.6 DRAWINGS

- A. The drawings are schematic in nature; however they show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Determine exact locations by review of equipment manufacturer's data, by job site measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. The size of the electrical equipment indicated on the Drawings may be based on the dimensions of a particular manufacturer. While other listed manufacturers will be acceptable, it is the responsibility of the Contractor to determine if the equipment that Contractor proposes to furnish will fit in the space. The drawings are not intended to show exact locations of conduit and wire, or to indicate all wire terminators, connectors, conduit fittings, boxes or supports, but rather to indicate distribution, circuitry, and control.
- B. The Electrical Drawings are diagrammatic in character and cannot show every connection or conduit in its exact location. These details are subject to the requirements of ordinances as well as structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades to avoid interference between the various phases of work. Work shall be laid out to be concealed in furred chases and suspended ceilings, etc., when located in finished portions of the building, unless specifically noted to be exposed. Work shall be installed to avoid the crippling of structural members. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- C. When the mechanical and electrical Drawings do not give exact details as to the elevation of pipe, conduit and ducts the systems shall be physically arranged to fit in the space available at the elevations intended and with the proper grades for the functioning of the system involved. Exposed conduit is generally intended to be installed true and square to the building construction and located as high as possible against the structure in a neat and workmanlike manner. The Drawings do not show all required offsets and their location details. Work shall be concealed in all finished areas.

1.7 SUBMITTALS

- A. Specification Review:
 - 1. Include a paragraph-by-paragraph written specification review for each product listed requiring a submittal. Denote any proposed deviations from specifications.

1.8 EXISTING CONDITIONS

- A. Do all work required to maintain electrical services to the Owner occupied portions of the building during construction.
- B. No connection to existing services or utilities shall be made without Owner's knowledge and permission. All such connections shall be planned and scheduled to minimize the length of service interruption required. Request for shutdown shall be made to Owner at least two (2) weeks in advance and shall be accompanied by detailed written schedule of activities during shutdown and list of materials required for connection and renewal of service. It shall be understood that all such service interruptions shall be made at the Owner's convenience, not the Contractor's. No increase in contract amount will be allowed for reasons of premium time, inefficiency of operations or other considerations not calculated in original bid.

- C. All items removed shall be stored on-site. Schedule a review of the items with the Owner. Remove from site all items the Owner does not choose to keep. Deliver Owner designated items to Owner's storage facility.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging and labeled with manufacturer's identification.
- B. Protect from weather, construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- C. Do not deliver items to project before the time of installation. Limit the shipment of bulk and multiple-use materials to quantities needed for immediate installation.

PART 2 - PRODUCTS

edit quantities to match job size

- A. Provide allowance in bid for the following items
 - 1. Twenty-five (25) 20A/1P circuits, each 100 feet in length from source, for use as required during construction. Include one duplex receptacle per circuit
 - 2. Twenty-five (25) light switching circuit drops, each twenty feet in length for use as required during construction. Include one 277V light switch per circuit
 - 3. Ten (10) additional exit signs for use as required during construction.
 - 4. Items shall be provided with all associated labor and necessary accessories (conductor, conduit, supports, etc.) required for proper installation.

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction.
- C. When performing work on energized equipment or circuits, use personnel experienced and trained in similar operations.
- D. Remove, relocate, and extend existing installations to accommodate new construction.
- E. Repair adjacent construction and finishes damaged during demolition and extension work.

3.2 OWNER INSTRUCTION

- A. Provide on-site Owner training for all new equipment.

- B. The Operation and Maintenance manuals and actual equipment installed shall be used as the basis for instruction.
- C. At the conclusion of the on-site training program require the Owner personnel to sign a written certification indicating they have completed the training and understand equipment operation. Include copy of training certificates in final Operation and Maintenance manual submission.

END OF SECTION 26 05 00

SECTION 26 05 19 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Provide a complete system of building wire and cable for all electrical loads.

1.3 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 - 1. Provide stranded conductors for all wiring.
 - 2. Conductors not smaller than 12 AWG for power and lighting circuits.
 - 3. Conductors not smaller than 16 AWG for control circuits.
 - 4. 10 AWG conductors for 20 ampere, 120 volt branch circuits longer than 75 feet
 - 5. 10 AWG conductors for 20 ampere, 277 volt branch circuits longer than 200 feet.
 - 6. Copper.
- B. Wiring Methods: Provide the following wiring methods:
 - 1. Concealed Dry Interior Locations: Use only Type THHN/THWN-2 insulation, in raceway.
- C. Branch Circuit Conductors: No branch circuit conductors are allowed in or under any slab on grade unless specifically indicated on drawings.

1.4 COORDINATION

- A. Where wire and cable destinations are indicated and routing is not shown, determine routing and lengths required.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Manufacturers:
 - 1. Southwire
 - 2. Republic
 - 3. Alan
 - 4. Encore
- B. Product Description: Single conductor insulated wire.
- C. Conductor: Copper.
- D. Insulation: NFPA 70; Type THHN/THWN-2 insulation for feeders and branch circuits.

2.2 TYPE AC CABLE

- A. **Acceptable Use:** Install, at Contractor's option, only for service to light fixtures above accessible ceilings, limit length to six (6) feet whips from accessible junction box to light fixtures.
- B. Manufacturers:
 - 1. Atkore
 - 2. Southwire
- C. Product Description: A fabricated assembly of insulated conductors in a flexible metallic enclosure.
- D. Comply with NEC 320.
- E. Support: Provide separate support to structure for all Type AC cable, spacing not exceeding three (3) feet and at each junction box.
- F. Provide an insulated green grounding conductor in all Type AC cable.
- G. Provide insulated throat fittings at all terminations of Type AC cable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.2 EXISTING WORK

- A. Remove exposed and abandoned wire and cable, including abandoned wire and cable above accessible ceiling finishes. Patch surfaces where removed cables pass through building finishes.
- B. Disconnect abandoned circuits and remove circuit wire, cable and conduit. Remove abandoned boxes when wire and cable servicing boxes is abandoned and removed. Install blank cover for abandoned boxes not removed.
- C. Provide access to existing to remain wiring connections and requiring access. Modify installation or install access panel.
- D. Extend existing circuits using materials and methods compatible with existing electrical installations or as specified.

3.3 INSTALLATION

- A. Route wire and cable to meet Project conditions.
- B. Neatly train and lace wiring inside boxes, equipment, and panelboards.

- C. Identify and color code wire. Identify each conductor with its circuit number or other designation indicated.
- D. Special Techniques - Wiring Connections:
1. Clean conductor surfaces before installing lugs and connectors.
 2. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 - a. MDF/IDF room branch circuits: All branch circuits shall be dedicated and unspliced. Provide dedicated branch circuit 20 or 30 amperes, #10 and or #12 wire, unspliced from wiring device all the way back to the overcurrent device. Do not share ground with any other circuit.
 - b. Computer branch circuits: All branch circuits shall be dedicated. Provide dedicated branch circuit 20 amperes, #10 and or #12 wire from wiring devices all the way back to the overcurrent device. Do not share neutral with any other circuit.
 - c. Kitchen branch circuits: All branch circuits for 125 volt, single phase, 15 and 20 ampere receptacles shall be dedicated. Provide dedicated branch circuit 20 amperes, #10 and or #12 wire from wiring devices all the way back to the overcurrent device. Do not share neutral or ground with any other circuit.
 3. Tape uninsulated conductors and connectors with electrical tape rated to 150 percent of insulation rating of conductor.
 4. Install split bolt connectors for copper conductor splices and taps, 6 AWG and larger.
 5. Install solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 6. Install insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.4 WIRE COLOR

A. COLOR CODES FOR CONDUCTORS FOR BRANCH CIRCUITS AND FEEDERS

	Wire Sizes #10 and Smaller: Use Continuous Color Coded Insulation (Note 01)				Wire Sizes #6 and Smaller: Use Continuous Color Coded Insulation (Note 02)	
<u>System/Phase</u>	A	B	C	N	G	IG
120/208	Black	Red	Blue	White	Green	Green/Yellow Stripe
120/240	Black	Orange	Blue	White w/color stripe (Note 03)	Green	Green/Yellow Stripe
277/480	Brown	Purple	Yellow	Gray	Green	Green/Yellow Stripe

Table Notes:

1. Wire size #8 and larger, black conductors with color marking tape at each termination and where accessible; colors as noted above.

2. Wire sizes #4 and larger, black conductor with green marking tape at each termination and where accessible.
 3. Provide white (no stripe) insulation when 120/208V system is not present at this installation.
 4. Color indicated is based on accepted standards. Contractor is to verify and provide colors as required by the local authority.
- B. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number and provide color coding at each junction box containing more than one neutral.
- C. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- D. Feeder Circuit Conductors: Uniquely color code each phase.
- E. Ground Conductors:
For 6 AWG and smaller: Green.
For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.5 GROUPING OF CIRCUITS

- A. Limit the number of current carrying conductors per conduit to 3. Neutrals serving computer receptacle branch circuits shall be counted as current carrying. Grounds shall not be counted.
- B. Grouping different voltages is not allowed.
- C. Provide metal box sizes per NEC Table 314.16 (A).
- D. Provide conduit per NEC Annex C.
- E. Neutrals serving branch circuits shall not be shared. Provide dedicated neutral per circuit.

3.6 POWER LIMITED CIRCUIT INSTALLATION

- A. Provide a complete system of raceway and covered junction boxes for all power limited circuits installed exposed in finished spaces and spaces without a ceiling.
- B. Provide raceway for all power limited circuit wiring within wall cavities and above sheet rock, plaster and other "hard" (non-lay-in) ceiling types of construction.
- C. Labeling: Provide labels on all junction boxes.
 1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the system's wiring name.

END OF SECTION 26 05 19

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

CONDITIONS OF THE CONTRACT AND DIVISION 1, as applicable, apply to this Section.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Conduit supports.
 - 2. Formed steel channel.
 - 3. Spring steel clips.
 - 4. Sleeves.
 - 5. Mechanical sleeve seals.
 - 6. Firestopping relating to electrical work.
 - 7. Firestopping accessories.
 - 8. Equipment bases and supports.

1.3 REFERENCES

- A. Underwriters Laboratories Inc.:
 - 1. UL 263 - Fire Tests of Building Construction and Materials.
 - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
 - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
 - 4. UL - Fire Resistance Directory.

1.4 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to Building Code and UL for fire resistance ratings and surface burning characteristics.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with the Building Code.

PART 2 - PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. Electroline Manufacturing Company
 - 3. O-Z Gedney Co.
 - 4. Appleton
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. B-Line Systems
 - 3. Midland Ross Corporation, Electrical Products Division
 - 4. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.3 SLEEVES

- A. Sleeves for raceway Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for raceway Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.
- C. Sleeves for raceway Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL Listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

2.4 SPRING STEEL CLIPS

- A. Product Description: Mounting clamp, and screw.

2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
 - 1. Thunderline Link-Seal, Inc.
 - 2. NMP Corporation

- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.6 FIRESTOPPING

- A. Manufacturers:
 - 1. Dow Corning Corp.
 - 2. Fire Trak Corp.
 - 3. Hilti Corp.
 - 4. International Protective Coating Corp.
 - 5. 3M fire Protection Products .
 - 6. Specified Technology, Inc.
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
 - 1. Silicone Firestopping Elastomeric Firestopping: Multiple component silicone elastomeric compound and compatible silicone sealant.
 - 2. Foam Firestopping Compounds: Multiple component foam compound.
 - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
 - 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral or ceramic fiber stuffing insulation with silicone elastomer for smoke stopping.
 - 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
 - 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
 - 7. Firestop Pillows: Formed mineral fiber pillows.

2.7 FIRESTOPPING ACCESSORIES

- A. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
- B. General:
 - 1. Furnish UL Listed products.
 - 2. Select products with rating not less than rating of wall or floor being penetrated.
- C. Non-Rated Surfaces:
 - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where conduit is exposed.
 - 2. For exterior wall openings below grade, furnish modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill annular space between conduit and cored opening or water-stop type wall sleeve.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.
- B. Verify openings are ready to receive firestopping.

3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
 - 1. Concrete Structural Elements: Provide precast inserts, expansion anchors, powder actuated anchors or preset inserts as required.
 - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, steel ramset fasteners or welded fasteners as required.
 - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors as required.
 - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts or hollow wall fasteners as required.
 - 5. Solid Masonry Walls: Provide expansion anchors or preset inserts as required.
 - 6. Sheet Metal: Provide sheet metal screws.
 - 7. Wood Elements: Provide wood screws.
- B. Inserts:
 - 1. Install inserts for placement in concrete forms.
 - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over four (4) inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- C. Install conduit and raceway support and spacing in accordance with NEC.
- D. Do not fasten supports to suspended ceiling support system, pipes, ducts, mechanical equipment, or conduit.
- E. Install multiple conduit runs on common hangers.
- F. Supports:
 - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
 - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
 - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards one (1) inch off wall.
 - 4. Support vertical conduit at every floor.

3.3 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating.
- D. Compress fibered material to maximum 40 percent of its uncompressed size.

- E. Place intumescent coating in sufficient coats to achieve rating required.
- F. Remove dam material after firestopping material has cured.
- G. Fire Rated Surface:
 - 1. Seal opening at all rated floors and walls as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Pack void with backing material.
 - d. Seal ends of sleeve with UL Listed fire resistive silicone compound to meet fire rating of structure penetrated.
 - 2. Where cable tray, bus, or conduit, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- H. Non-Rated Surfaces:
 - 1. Seal opening through non-fire rated floors and walls as follows:
 - a. Install sleeve through opening and extending beyond minimum of one (1) inch on both sides of building element.
 - b. Size sleeve allowing minimum of one (1) inch void between sleeve and building element.
 - c. Install type of firestopping material recommended by manufacturer.
 - 2. Install escutcheons where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.
 - 3. Exterior wall openings below grade: Assemble rubber links of mechanical seal to size of conduit and tighten in place, in accordance with manufacturer's instructions.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Provide mechanical sleeve seals.
- B. Interior conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors and walls one (1) inch above finished floor level. Caulk sleeves.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.1 SUMMARY

- A. Section includes conduit and tubing, wireways, outlet boxes, pull and junction boxes.

1.2 REFERENCES

- A. American National Standards Institute:
 - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
 - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
 - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
 - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
 - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal junction and pull boxes. Provide flush mounting outlet box in finished areas.
- C. Concealed Dry Locations: Provide rigid steel intermediate metal conduit on electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- D. Exposed Dry Locations: Provide rigid steel conduit, intermediate metal conduit or electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.

- E. In Slab or Under Slab on Grade: No branch circuit raceway is allowed in any slab or under slab on grade unless specifically indicated on drawings.

1.4 DESIGN REQUIREMENTS

- A. Minimum Raceway Size: 3/4 inch.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- B. Protect PVC conduit from sunlight.

1.6 COORDINATION

- A. Coordinate installation of outlet boxes and raceway for equipment connected under other Divisions.
- B. Coordinate installation of conduit for control wiring in mechanical rooms and in inaccessible locations such as walls and hard ceilings.
- C. Coordinate installation of conduit for all other low-voltage systems in inaccessible locations and all other locations required by drawings or specifications for those systems.
- D. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes. Refer to Architectural elevations and equipment specifications and coordinate device locations prior to electrical rough-in.

PART 2 - PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
 - 1. Carlon Electrical Products
 - 2. Hubbell Wiring Devices
 - 3. Thomas & Betts Corp
 - 4. Walker Systems Inc.
 - 5. The Wiremold Co.
 - 6. Multi Cell
 - 7. O-Z Gedney
 - 8. Raco.
 - 9. or approved equal.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Intermediate Metal Conduit (IMC): Rigid steel.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit
- E. Electrical Metal Tubing (EMT): All EMT fittings shall be steel not die-cast metal. All conduit stub-ups above ceiling for low voltage and data to be provided with insulating bushing.

- F. Flexible Metal Conduit (Flex): Conduit fittings shall be steel. Provide plastic anti-short bushing for all flex fittings. Comply with NEC 348.
- G. Liquidtight Flexible Metal Conduit: Shall be same as flexible metal conduit specified above except Article 350 in NEC.
- H. PVC-Coated Rigid Steel Conduit: Galvanized rigid steel with additional external coating for 40 mil polyvinyl chloride jacket (PVC). Conforming to UL Standard 6. ANSI C80.1 and NEMA Standard No. RN.1.
 - 1. Manufacturer:
 - a. Ocal Inc.
 - b. Perma Cote Industries
 - c. Rob-Roy Industries
 - d. or Approved equal.
- I. PVC-Rigid Nonmetallic Conduit: PVC and fittings that are listed per the UL Standards. Comply with NEMA Standard TC-2.
- J. Nonmetallic Multi Duct: Provide nonmetallic multi duct that is UL Listed.
 - 1. Type: four (4) inches schedule 40 PVC outer duct, four 1.25 inch ducts of ribbed polyethylene. Duct shall have six (6) inch deep end bell on one end, spigot on the other end.
 - 2. Multi Duct shall have gaskets to seal the inside and outside walls of the inner duct.

2.2 ENCLOSURES

- A. Pull Boxes, Junction Boxes, Cabinets, and Wireways: Provide pull boxes, junction boxes, wireways, and cabinets wherever necessary for proper installation of various electrical systems according to the National Electrical Code and where indicated on the Drawings.
- B. Minimum Size: That size shown on the drawings, as required for the specific function, or as required by the National Electrical Code, whichever is larger.
- C. Construction:
 - 1. Indoors in Dry Areas and Not Buried in Slab: Code gage steel - NEMA 1 construction - sides formed and welded, screw covers unless indicated hinged cover or door on drawings. Hinged doors shall be similar to panelboard doors with the same type locking device. Knockouts shall be factory made or formed O-Z Gedney Type PB or approved equal.
 - 2. Outdoors or Indoors in Wet Areas and Not Buried in Slab: Same as specified above for indoor except provide NEMA 3R (designated by 3R or RT) unless indicated or specified to be NEMA 4 (designated by 4 or WP) or other type rating.
 - 3. Indoors Buried in Slab: Watertight, galvanized cast iron in floors on or below grade, otherwise concrete tight stamped steel.
 - 4. Outdoors Buried in Earth: Watertight, Polymer concrete similar to Hubbell Power System, Inc. "Quazite" or precast concrete type manufactured by Brooks Product, Inc brand for Oldcastle Precast, Inc. Precast box shall have appropriate structural rating for intended use. Install on a level poured concrete base to provide a solid bearing surface. Provide a bolted cast iron traffic cover with foundry-cast marking "Electrical", "Communications" or "Telephone" as applies. Top of enclosure shall be one (1) inch above finished grade in earth. Top of enclosure shall be flush with finished pavement.

2.2 WIREWAY

- A. Manufacturers: Same as Metal Conduit.

- B. Product Description: General purpose.
- C. Size: As determined by Contractor in accordance with NEC 376.
- D. Cover: Screw cover.
- E. Connector: Slip-in.
- F. Fittings: Lay-in type.
- G. Finish: Rust inhibiting primer coating with gray enamel finish.

2.3 OUTLET BOXES

- A. Manufacturers: Same as Metal Conduit.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
 - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
 - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast fer alloy. Furnish gasketed cover by box manufacturer.
- D. Wall Plates: As specified in Section 26 27 26.

2.4 FLOOR BOXES

- A. UL listed for wet application, watertight cast-iron, scrub-shield compliant.
- B. NEMA OS-1, sheet steel outlet boxes, device boxes, covers, and box supports.
 - 1. Floor: Fully adjustable before and after pour.
 - 2. UL Listed for wet application when installed into concrete, stone, tile or floor without carpet cover. Provide carpet flange where installed in carpet.
 - 3. Provide watertight, cast iron on floors at or below grade, and provide concrete tight stamped steel on all upper floors.
 - 4. Multi Gang Floor Box: Provide a minimum of a 4-gang on grade floor box Wiremold evolution #RFB series. Or approved equal by engineer. Acceptable manufacturer equals shall be from Appleton, Carlon, Crouse-Hinds, Hubbell or FSR. Floor box shall be provided with two duplex receptacles, (1) 3/4" conduit for power and (1) 1-1/2" conduit for data. Conduits shall be routed from the floor box to the nearest full height wall and up to the accessible ceiling plenum. Provide with pull string. Data conduits shall be routed from the floor box to the wall with the AV backbox for TV and from backbox in wall to the accessible ceiling plenum no daisy chain of low voltage conduits is allowed. Refer to Architect for exact location, cover types and finish prior to installation and procurement. Refer to submitted electrical power floor plan keyed notes for specific floor box types and locations.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 EXISTING WORK

- A. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces.
- B. Remove concealed abandoned raceway to its source.
- C. Disconnect abandoned outlets and remove devices. Remove abandoned outlets when raceway is abandoned and removed. Install blank cover for abandoned outlets not removed.
- D. Maintain access to existing boxes and other installations remaining active and requiring access. Modify installation or provide access panel.
- E. Extend existing raceway and box installations using materials and methods compatible with existing electrical installations, or as specified.
- F. Clean and repair existing raceway and boxes to remain or to be reinstalled.

3.3 INSTALLATION - RACEWAY

- A. Ground and bond raceway and boxes in accordance with Section 26 05 26.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 25 29.
- C. Identify raceway and boxes in accordance with Section 26 05 53.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.
- E. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- F. Arrange raceway supports to prevent misalignment during wiring installation.
- G. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- H. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.
- I. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- J. Do not attach raceway to ceiling support wires or other piping systems.
- K. Construct wireway supports from steel channel specified in Section 26 25 29.
- L. Route exposed raceway parallel and perpendicular to walls.
- M. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- N. Maximum Size Conduit in Slab Above Grade: 3/4 inch.
- O. Maintain clearance between raceway and piping for maintenance purposes.

- P. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees Fahrenheit.
- Q. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- R. Bring conduit to shoulder of fittings; fasten securely.
- S. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- T. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes. DO NOT route conduit through the top of any outdoor disconnects, panels, etc. conduits must be routed through side or bottom only.
- U. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install hydraulic one-shot bender to fabricate factory elbows for bends in metal conduit larger than two (2) inch size.
- V. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- W. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.
- X. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- Y. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- Z. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- AA. Close ends and unused openings in wireway.
- BB. Provide tracer wire on all underground raceway outside building slab on grade.

3.4 RACEWAY TYPES

- A. The following raceway types are to be used in the following locations:
 - 1. Under Slab on Grade: Schedule 40 PVC.
 - 2. Outdoor Locations, Above Grade: Rigid galvanized steel.
 - 3. Wet and Damp Locations: Rigid galvanized steel.
 - 4. Exposed or Concealed Dry Locations, Indoors: EMT, IMC, or rigid galvanized steel.
 - 5. Underground:
 - a. All underground electrical wire in schedule 40 PVC or rigid galvanized steel, 208 volts or greater shall be encased in red concrete two (2) inches thick on all sides. Encasement not required under building slabs, parking lots or other paved surfaces. Red dye may not be applied to the top of the concrete.
 - b. All underground electrical wire in schedule 40 PVC or rigid galvanized steel, 120 volts or less shall have red warning tape 6" above raceway.
 - 6. Transformers and Motors: 24 inch flexible metal conduit to equipment.
 - 7. Kitchens and outdoor motor and transformer connections: Liquidtight flexible metal conduit for all exposed raceway.

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8. Cooling Towers: PVC coated rigid galvanized steel within 50 feet of tower.

3.5 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings and as approved by the Architect.
- B. Adjust box location up to ten (10) feet prior to rough-in to accommodate intended purpose.
- C. Orient boxes to accommodate wiring devices oriented as specified in Section 126 27 26.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Do not fasten boxes to ceiling support wires or other piping systems.
- G. Support boxes independently of conduit. Provide rigid support to structure for all junction boxes. Mount junction boxes within 18" of finished ceilings to facilitate future access. Locate junction boxes to allow ready access to junction box covers without removing any equipment.
- H. All outdoor boxes shall be UL listed for wet location service.
- I. Provide rigid support to structure for all junction boxes.
- J. Provide rigid support to structure for all conduit within 3 feet of each junction box and a maximum spacing of 10 feet.
- K. Install junction boxes above ceilings in readily accessible with no obstructions, locate within 18 inches of finished ceiling to facilitate easy access.
- L. For all flexible whips to light fixtures provide wire support at mid-length of whip to structure above with UL listed conduit support clip.
- M. Provide outlet boxes to meet depth requirement of Architectural walls. Refer to Architectural Spec Section 09250 and 10611 for wall partitions.

3.6 ADJUSTING

- A. Install knockout closures in unused openings in boxes.

3.7 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.
- B. Clean exposed surfaces and restore finish.

3.8 INSTALLATION - FLOOR BOXES

- A. Use cast floor boxes for installation in slab on grade.
- B. Set floor boxes level.

- C. Install boxes and fittings to preserve fire resistant rating of slabs and other elements, using materials and methods specified in Section 26 05 29.

3.9 ADJUSTING

- A. Adjust floor box flush with finish material.

3.10 CLEANING

- A. Clean interior of boxes to remove dust, debris, and other material.

3.11 ABOVE CEILING JUNCTION BOXES

- A. Labeling: Provide label on all above ceiling junction boxes.
 - 1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the panelboard name, branch circuit number(s) and voltage of conductors within the junction box. Junction boxes used for emergency power circuits to be painted red.
- B. Color Code: All Electrical junction boxes above ceiling shall be colored as follows.
 - 1. Yellow for 277V lighting
 - 2. Blue for 120V regular power
 - 3. Green for 120V computer power
 - 4. Brown for 277/480V equipment
 - 5. Red for emergency power

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Underground Warning Tape.
 - 3. Lockout Devices.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical identification, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and standards: Comply with the following:
 - 1. National Electrical Code, NFPA No. 70.
 - 2. NEMA standards applicable to the product provided.
 - 3. UL standards applicable to the product provided.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
 - 1. Panduit Corp.
 - 2. American Labelmark Co.
 - 3. Markal Corp.
 - 4. Calpico, Inc.
 - 5. Ideal Industries, Inc.

2.2 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- B. Emergency Power panels and Equipment: Laminated three-layer plastic with engraved white letters on **RED** background.
- C. Letter Size:
 - 1. 1/4 inch high letters for identifying individual equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.3 UNDERGROUND WARNING TAPE

- A. Description: four (4) inch wide plastic tape, colored red with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using screws, rivets, or adhesive.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards
 - b. Panelboards
 - c. Transformers
 - d. Service Disconnects
 - 1) Enclosed Switches
 - e. Motor Control Centers
 - f. Stand-alone Motor Controllers
 - g. Generators
 - h. Contactors
- C. Underground Warning Tape Installation:
1. Install underground warning tape along length of each underground conduit, raceway, or cable six (6) to eight (8) inches below finished grade, directly above buried conduit, raceway, or cable. Where multiple lines installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.
 2. Install line marker for underground wiring, both direct buried and in raceway.
- D. Printed Panelboard Directory:
1. Provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker for that panel, switchboard, or motor control center.
 2. Panelboard directory shall include a legend indicating insulation color corresponding each phase and voltage in the building electrical system.
 3. Copy in Owner's Manual.

3.3 ABOVE CEILING JUNCTION BOXES

- A. Labeling: Provide label on all above ceiling junction boxes.
 - 1. Provide permanent labeling with indelible black marker, in neat, legible print indicating the panelboard name, branch circuit number(s) and voltage of conductors within the junction box.

3.4 ARC FLASH WARNING LABEL

- A. Switchboards, panel boards and motor control centers requiring examination, adjustments, servicing or maintenance while energized shall be field marked to warn persons of arc flash hazards. Marking shall be located so as to be clearly visible to qualified persons before servicing or maintenance.

END OF SECTION 26 05 53

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 26.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the owner will manage the commissioning process.

1.3 RELATED WORK

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.4 SUMMARY

- A. This Section includes requirements for commissioning the Facility electrical systems, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.5 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.6 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 26 is part of the construction process. Documentation and testing of these systems, as well as training of the OWNER's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 26, is required in cooperation with the OWNER and the Commissioning Agent.

- B. The Facility electrical systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements:

1.7 SUBMITTALS

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the OWNER prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of Electrical systems will require inspection of individual elements of the electrical systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule electrical systems inspections as required to support the Commissioning Process.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the OWNER and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Engineer. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

3.4 TRAINING OF OWNER PERSONNEL

- A. Training of the OWNER operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be scheduled in coordination with the OWNER Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

END OF SECTION 26 08 00

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes wall switches; wall dimmers; receptacles; device plates and box covers. All devices shall be installed in outlet boxes of required size and volume.

1.3 REFERENCES

- A. National Electrical Manufacturers Association: Wiring devices shall comply with NEMA Standards WD-1 and WD-6.
- B. Wet Locations: Wiring devices and their enclosures installed outdoors and in wet locations shall be approved for that purpose.
- C. Minimum Raceway Size: 3/4 inch.

1.4 SUBMITTALS

- A. Submit manufactures product data for all wiring devices, indicate intended color and coverplate.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All devices shall be suitable for use intended, and have voltage and current ratings adequate for loads being served.

2.2 WALL SWITCHES

- A. Single Pole Switch, Toggle Style:
 - 1. Leviton 1221 Series, 20A, 120/277V.
- B. Double Pole Switch, Toggle Style:
 - 1. Leviton 1222 or 3032 Series, 20A or 30A, 120/277V.
- C. Three-way Switch, Toggle Style:
 - 1. Leviton 1223 Series, 20A, 120/277V.
- D. Four-way Switch, Toggle Style:
 - 1. Leviton 1224 Series, 20A, 120/277V.
- E. Indicator Switch, Toggle Style:
 - 1. Leviton 1201 Series, 20A, 120/277V. Switch illuminated when load is on.

- F. Locator Switch, Toggle Style:
 - 1. Leviton 1221 Series, 20A, 120/277V. Switch illuminated when load is off.

- G. Digital Time Switch:
 - 1. Wattstopper TS-400 digital time switch with optional visual warning to flash lights at 5 minutes and 1 minute prior to time-out.

- H. Key lock switches:
 - 1. Provide key lock switches for corridor lighting and other locations indicated on electrical drawings.
 - 2. 20 Amp rated.
 - 3. 120/277 Volt ac rated.
 - 4. Key-lock mechanism can only be turned ON or OFF with key.
 - 5. Single pole: Leviton 1221-2KL or approved equal.
 - 6. 3-Way: Leviton 1223-2kl or approved equal.
 - 7. 4-Way: Leviton 1224-2kl or approved equal.
 - 8. Provide 302 stainless steel wall plate for each switch.
 - 9. Provide 2 keys on ring for each switch.
 - 10. Include a brass tag on every key switch ring. Engrave tag; Example: "Hall East Lights".
 - 11. Key all switches alike to match the owners standard key. Coordinate with school District for key match.

- I. Color: As selected by Architect.

2.3 MOTOR RATED SWITCHES

- A. Provide where a switch is indicated as a local disconnect for all mechanical and plumbing equipment.
- B. Leviton MMS Series.

2.4 WALL DIMMERS

- A. Manufacturers:
 - 1. Lutron Nova "T" Series.
- B. Product Description: Semiconductor dimmer for incandescent lamps with ON-OFF switch.
- C. Body and Handle: Linear slide handle, color as selected by Architect.
- D. Voltage: 120 volts.

2.5 RECEPTACLES

- A. Single Convenience Receptacle:
 - 1. Leviton 5362A Series, 20A/125V.
- B. Duplex Convenience Receptacle:
 - 1. Leviton 5362 Series, 20A/125V, respectively.
- C. GFCI Receptacle:

1. Leviton 7899 Series, 20A/125V.
 2. Provide GFCI receptacles for all receptacles on 120v circuits installed in kitchens, bathrooms and outdoors (including rooftops).
- D. Isolated Ground Duplex Receptacle:
1. Leviton 5362-IG, 20A/125V.
- E. Duplex Tamper Resistant Receptacle/ USB Charger
1. Leviton T5832. Duplex 20A/125V receptacle with two 3.6A, 5VDC, 2.0 Type A USB Chargers.
- F. Provide 20 amp receptacle for single-receptacle branch circuits.
- G. For locations where a quadruplex or fourplex is required, provide 2-duplex receptacles under common coverplate.
- H. Color: As selected by Architect.

2.6 WALL PLATES

- A. Type 302 Stainless Steel with matching mounting screws.

2.7 MANUFACTURERS

- A. Each type of wiring device shall be furnished by one (1) manufacturer. The following will be acceptable providing the project specifications:
1. Leviton
 2. Pass & Seymour
 3. Hubbell / Bryant
 4. Cooper

PART 3 - EXECUTION

3.1 EXISTING WORK

- A. Disconnect abandoned circuits and remove raceway, wire, and cable. Remove abandoned boxes when connecting wire and cable is abandoned and removed. Install blank cover for remaining abandoned boxes.
- B. Maintain access to existing boxes and wiring connections remaining active and requiring access.
- C. Extend existing circuits using materials and methods compatible with existing electrical installations, or as specified.

3.2 INSTALLATION

- A. Route raceway and cable to meet Project conditions.
- B. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- C. Adjust box location up to ten (10) feet prior to rough-in when required to accommodate intended purpose.

- D. Do not install flush mounting box back-to-back in walls; install boxes with minimum 24 inches separation.
- E. Install devices plumb and level.

3.3 MOUNTING HEIGHTS

- A. As indicated on Drawings or if not indicated in accordance with the Architects instructions. All other telephone, Data, TV, etc. outlets shall be same as receptacle.

3.4 GANGED SWITCHES

- A. Install permanent barrier between all 277 Volt light switches ganged into one outlet box.
- B. Where multiple switches are grouped on one location, install switches under a one piece, multi-gang cover plate.
- C. Other telephone, data, TV, etc. outlets shall be same as receptacle.

3.5 GFCI

- A. Provide ground-fault circuit-interrupter type receptacles for all 15 and 20 amp receptacles shown on drawings in bathrooms, kitchens, mechanical rooms and outdoors.

END OF SECTION 26 27 26