

**2013 Bond Program
Series 1 Bid Package 8A Athens MEP Upgrades**

AHU, ERU and Secondary Unit Substations Pre-Purchase

BID PROPOSAL

Issued: January 30, 2015

***BIDS ARE DUE FEBRUARY 17, 2015**

Barton
 **Malow**



SECTION 00400
BID PROPOSAL FORM
(Submit TWO copies - Fill in all Blanks)

DATE: _____

TO: Troy School District Administration Office
4400 Livernois
Troy, MI, 48098

PROJECT: Troy School District 2013 Bond Program
Series 1, Bid Package 8A
Athens MEP Upgrades
AHU, ERU and Secondary Unit Substations
Pre-Purchase

ATTN: Todd Hensley
Purchasing Supervisor

CM :Barton Malow Company

Architect: TMP Architecture

Name of Bidding Co.:

Contact Name:

Email Address:

Business Address:

Phone Number:

**Bid Proposal for
Category(ies):**

Bidder, in compliance with the Advertisement to Bid for construction contemplated for Series 1, Bid Package 8A Athens MEP Upgrades: AHU, ERU and Secondary Unit Substations Pre-Purchase, having carefully examined the Bidding Documents, proposes to furnish all materials, equipment and machinery as listed in the Bid Category(ies). Manufacturer agrees to ship from the factory to the specific project site by insured carrier (FOB Job Site). Sales tax shall be included in bid. Product Data shall be provided for each type of product bid. Failure to provide this product data will result in an incomplete bid proposal form and may be disqualified by Troy School District.

If identified as one of the apparent lowest bidder(s) for a Bid Category, Bidder agrees to coordinate with the architect, engineer and CM. Upon selecting a desired manufacturer, the manufacturer agrees to immediately begin fabrication of equipment upon receiving approved submittals and a purchase order agreement with Troy School District.

Bidder, if awarded a contract, agrees to: (1) Furnish all mechanical units, at the price bid below, to the contractor whom receives contract award to install these units. (2) Hold their 2015 bid price through 2016.

This bid proposal shall be used in determining total delivery prices for the years 2015 and 2016. Bidder agrees that the price bid is applicable to deliveries made in either year. Prices of equipment shall include all accessories required in order to provide a functional unit, including but not limited to heating/cooling coils, filters, fans, etc.

(Show amounts in both words and figures. In case of discrepancy, amount shown in words will govern)

BID CATEGORY	WRITTEN DESCRIPTION/AMOUNT(S)	BID AMOUNT IN FIGURES
1. Bid Category No. 237000 Central HVAC Equipment	_____	\$ _____
	_____ DOLLARS	
2. Bid Category No. 237200 Air- Air Energy Recovery Equipment	_____	\$ _____
	_____ DOLLARS	
3. Bid Category No. 261116 Secondary Unit Substations	_____	\$ _____
	_____ DOLLARS	

VOLUNTARY ALTERNATES: If available, manufacturer shall provide an alternate for expedited delivery of equipment. In order to be considered as an alternate, manufacturer shall provide the typical lead time of specific equipment, the expedited lead time available for that equipment and the additional cost associated with that expedition.

BID CATEGORY CODE	TYPICAL LEAD TIME (WEEKS)	EXPEDITED LEAD TIME (WEEKS)	ADDITIONAL COST PER UNIT TO EXPEDITE
1 237000 - Central HVAC Equipment	_____	_____	\$ _____ /UNIT
2 237200 - Air- Air Energy Recovery Equipment	_____	_____	\$ _____ /UNIT
3 261116 - Secondary Unit Substations	_____	_____	\$ _____ /UNIT

INDIVIDUAL UNIT PRICES: All manufacturers are required to provide individual pricing for each type of unit. The following prices are requested for accounting purposes only and will not be used to determine the low bidder. Individual unit prices shall include all accessories in order to provide a functional unit, including but not limited to heating/cooling coils, filters, fans, etc.. **Failure to quote the following individual prices will result in an incomplete bid proposal form and may be disqualified by Troy School District.**

BID CATEGORY	DESCRIPTION	TOTAL 2015/2016 DELIVERY PRICE		
237000 - Central				
1 HVAC				
Equipment	AHU-1	\$	HVU- 1	\$
	AHU-2	\$	HVU- 2	\$
	AHU-3	\$	HVU- 3	\$
	AHU-4	\$	HVU- 4	\$
	AHU-5	\$	HVU- 5	\$
	AHU-6	\$	HVU- 6	\$
	AHU-7	\$	HVU- 7	\$
	AHU-8	\$	HVU- 8	\$
	AHU- 9	\$	HVU- 8	\$
	AHU- 10	\$	HVU- 9	\$
	AHU- 11	\$	HVU- 10	\$
	AHU- 12	\$	HVU- 11	\$
	AHU- 13	\$	HVU- 12	\$
	AHU- 14	\$	HVU- 13	\$
	AHU- 15	\$	HVU- 14	\$
	AHU- 16	\$	HVU- 15	\$
	AHU- 17	\$	HVU- 16	\$
	AHU- 18	\$		
	AHU- 19	\$		
	AHU- 20	\$		
	AHU- 21	\$		
	AHU- 22	\$		
	AHU- 23	\$		
	AHU- 24	\$		
	AHU- 25	\$		
	AHU- 26	\$		
	AHU- 27	\$		
	AHU- 28	\$		

BID CATEGORY	DESCRIPTION	TOTAL 2015/2016 DELIVERY PRICE
237200 - Air-Air Energy Recovery Equipment	DU- 1	\$

BID CATEGORY	DESCRIPTION	TOTAL 2015/2016 DELIVERY PRICE
261116 - Secondary Unit Substations	Substation No. 1	\$
	Substation No. 2	\$

Bidder understands that the Owner reserves the right to reject any or all Bid Proposals and to waive any informalities or irregularities therein.

Bidder acknowledges receipt of the following Addenda (identify no. and date of each): _____

Bidder accepts the provisions of the Bidding and Contract Documents and certifies that this Bid Proposal is submitted in good faith and without collusion with any other person or entity submitting a Bid Proposal for the Furnishing of Materials, Equipment or Work.

END OF SECTION 00400

PROJECT MANUAL FOR THE CONSTRUCTION OF:

PROJECT:

2013 BOND PROGRAM SERIES 1

ATHENS HIGH SCHOOL MEP UPGRADES

BID PACKAGE NO. 8A

OWNER:

TROY SCHOOL DISTRICT
4400 Livernois
Troy, Mi. 48098

TMP PROJECT NO.: 13173B

DATE: January 27, 2015

ISSUED FOR PRE- PURCHASE

ARCHITECT

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CONSTRUCTION MANAGER

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MECHANICAL & ELECTRICAL ENGINEER

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END OF SECTION

MECHANICAL ABBREVIATIONS

<u>Abbreviation</u>	<u>Description</u>
AHU	Air Handling Unit
APD	Air Pressure Drop
B	Boiler
BHP	Brake Horsepower
BTU	British Thermal Unit
BTUH	British Thermal Unit Per Hour
CAP	Capacity
CAV	Constant Air Volume
CC	Cooling Coil
CFH	Cubic Feet Per Hour
CFM	Cubic Feet Per Minute
CH	Chiller
CHW	Chilled Water
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CLG	Cooling
COP	Coefficient of Performance
CP	Circulation Pump
EAT	Entering Air Temperature
EDB	Entering Dry Bulb Temperature
EER	Energy Efficiency Ratio
EF	Exhaust Fan
EFF	Efficiency
ESP	External Static Pressure
EWT	Entering Water Temperature
EXH	Exhaust
FA	Face Area
FCU	Fan Coil Unit
FT	Feet
FTR	Finned Tube Radiation
FV	Face Velocity
GA	Gauge
GPM	Gallons Per Minute
HC	Heating Coil
HP	Horsepower
HPL	Heat Pump Loop
HPLR	Heat Pump Loop Return
HPLS	Heat Pump Loop Supply
HR	Hour
HTG	Heating
HV	Heating Ventilating
HVAC	Heating, Ventilating, Air Conditioning
HWH	Hot Water Heating
HWRH	Hot Water Heating Return
HWSH	Hot Water Heating Supply
HZ	Hertz
IN	Inches
KW	Kilowatt
KWH	Kilowatt-Hour
LAT	Leaving Air Temperature
LBS	Pounds
LDB	Leaving Dry Bulb Temperature

SECTION 014214
MECHANICAL
ABBREVIATIONS

LWB	Leaving Web Bulb Temperature
LWT	Leaving Water Temperature
MBH	Thousand British Thermal Units Per Hour
MCA	Minimum Circuit Ampacity
MCC	Motor Control Center
MIN	Minimum
OA	Outside Air
OAT	Outside Air Temperature
PPM	Parts Per Million
PRESS	Pressure
RA	Return Air
RS	Refrigerant Suction
RTU	Rooftop Unit
SA	Sound Attenuator
SA	Supply Air
SECT	Section
SF	Supply Fan
SP	Static Pressure
SQFT	Square Foot/Square Feet
TEMP	Temperature
THA	Total Heat Absorbed
THR	Total Heat Rejected
THS	Terminal Heat Supply
TYP	Typical
UV	Unit Ventilator
VUV	Vertical Unit Ventilator
WC	Water Column
WG	Water Gauge

END OF SECTION

MECHANICAL GENERAL REQUIREMENTS

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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 work of this Section.
- 1.2 SUMMARY
- A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 01 Specification Sections.
- 1.3 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.
1. AABC – Associated Air Balance Council.
 2. ABMA - American Bearing Manufacturers Association.

3. ABMA – American Boiler Manufacturers Association.
4. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The).
5. AMCA - Air Movement and Control Association International, Inc.
6. ANSI – American National Standards Institute.
7. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
8. ASTM – American Society for Testing Materials.
9. CDA – Copper Development Association.
10. CGA – Compressed Gas Association.
11. CSA – CSA International.
12. HI – Hydraulic Institute.
13. Intertek – Intertek Group.
14. NAIMA – North American Insulation Manufacturers Association.
15. NEBB – National Environmental Balancing Bureau.
16. NEC – National Electrical Code.
17. NECA - National Electrical Contractors Association.
18. NEMA – National Electrical Manufacturer’s Association.
19. NFPA – National Fire Protection Association.
20. SMACNA – Sheet Metal and Air Conditioning Contractors National Association.
21. UL – Underwriter’s Laboratories, Inc.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 PERFORMANCE REQUIREMENTS

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified and as indicated on Drawings.
 - 1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.
 - 1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
 - 2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.
- C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Perform work to avoid interference with the work of other trades. Remove and relocate work which in the opinion of the Owner's Representatives causes interference.
- G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (Intertek, CSA, etc.).

1.6 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.
- B. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.
- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.
- D. Refer to Division 22 Section "Domestic Water Piping" for purchase and installation of potable water meters.

1.7 DRAWINGS

- A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly. Provide fittings, valves, and accessories as required to meet actual conditions.
- C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid.
- C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.
- D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
 - 1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.

1.9 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.
- B. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been observable, ascertainable or reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 01 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
 - 1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
 - 2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.
- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 SUBMITTALS

- A. Submit project specific submittals for review in compliance with Division 01.
- B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 01 for submittal quantities.
- C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned "Rejected". Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.
- D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned "Rejected".
- E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.

- F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.
1. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.
 2. Contractor is responsible for:
 - a. Dimensions, which shall be confirmed and correlated at the job site.
 - b. Fabrication processes and techniques of construction.
 - c. Quantities.
 - d. Coordination of Contractor's work with all other trades.
 - e. Satisfactory performance of Contractor's work.
 - f. Temporary aspects of the construction process.
- G. Submit detailed shop drawings of piping systems showing pipe routing and types and locations of all pipe hangers.
- H. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

- A. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 Specification Sections.
- B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.
- C. Format: Submit operations and maintenance manuals in the following format:
1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
 - b. Enable inserted reviewer comments on draft submittals.
- D. Operation and maintenance instructional manuals shall be submitted a minimum of four (4) weeks prior to functional testing.

- E. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
 - 1. Routine maintenance procedures.
 - 2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
 - 3. Trouble-shooting procedures.
 - 4. Contractor's telephone numbers for warranty repair service.
 - 5. Submittals.
 - 6. Recommended spare parts lists.
 - 7. Names and telephone numbers of major material suppliers and subcontractors.
 - 8. System schematic drawings.

1.14 RECORD DRAWINGS

- A. Submit record drawings in compliance with Division 01.
- B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum which have been neatly marked to represent as-built conditions for all new mechanical work.
- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.15 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.
- E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 WARRANTY

- A. Warranty: Comply with the requirements in Division 01 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the

Owner's satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION WORK

- A. All demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include all items such as, but not limited to, existing piping, draining of piping, pumps, ductwork, supports and equipment where such items are not required for the proper operation of the modified system.
- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner shall move and store these materials. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.
- E. Clean and flush the interior and exterior of all existing relocated equipment and its related piping, valves, and accessories that are to be reused of all mud, debris, pipe dope, oils, welding slag, loose mill scale, rust and other extraneous material so that the existing equipment and all accessories can be repainted and repaired as required to place in first-class working condition.
- F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains. Cap or plug piping with same or compatible piping material.
- G. Cap ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation.
 - 1. Cap or plug piping with same or compatible piping material.
 - 2. Cap or plug ducts with same or compatible ductwork material.

3.2 REFRIGERANT HANDLING

- A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:

1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.
 2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
 3. United States Environmental Protection Agency (US EPA) requirements of Section 8 08 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.
- B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.3 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.
- B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.
- C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
- D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.4 TEMPORARY SERVICES

- A. Provide temporary service as described in Division 01.
- B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

3.5 WORK INVOLVING OTHER TRADES

- A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.6 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.
- B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.
- D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.
- E. Operation of the following systems shall be demonstrated:
 - 1. Air Handling Systems.
 - 2. Refrigeration Systems.
 - 3. Chilled Water Systems.
 - 4. Condenser Water Systems.
 - 5. Process Cooling Systems.
 - 6. Heating Systems.
 - 7. Steam Pressure Reducing Stations.
 - 8. Condensate Receivers.
 - 9. Domestic Water Booster Systems.
 - 10. Domestic Hot Water Heaters.
 - 11. Domestic Hot Water Mixing Stations.
 - 12. Compressed Air Systems.
 - 13. Vacuum Systems.
 - 14. Purified Water Systems.
 - 15. Chemical Treatment Systems.
 - 16. Energy Recovery Systems.
 - 17. Temperature Controls.
 - 18. Building Automation System.
 - 19. Lab Airflow Controls.
 - 20. Exhaust Systems.
 - 21. Smoke Purge Systems.
- F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

3.7 PROJECT COMMISSIONING

- A. Refer to Division 01 "Project Commissioning" and the Commissioning Manual.
- B. Purpose: Training, documentation and verification of the operation and functional performance of mechanical systems for compliance with the "design intent."

****END OF SECTION****

MOTORS

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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.
- B. Related Sections include the following:
 - 1. Division 20 "Mechanical General Requirements."
 - 2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
 - 3. Division 20 Section "Variable Frequency Controllers".
 - 4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
 - 5. Division 26 Section "Enclosed Switches and Circuit Breakers".
 - 6. Division 26 Section "Enclosed Controllers".
 - 7. Division 26 Section "Fuses".

1.2 SUMMARY

- A. This Section includes basic requirements for factory-installed and field-installed motors, enclosed controllers, disconnect switches, and fuses.

1.3 DEFINITIONS

- A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)
- B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.
- C. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.
- D. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:
 - 1. Compatible with the following:
 - a. Magnetic controllers.
 - b. Multispeed controllers.
 - c. Reduced-voltage controllers.
 - d. Solid-state controllers.
 - e. Variable frequency controllers.
 - 2. Designed and labeled for use with variable frequency controllers, and suitable for use throughout speed range without overheating.
 - 3. Matched to torque and horsepower requirements of the load.
 - 4. Matched to ratings and characteristics of supply circuit and required control sequence.
- B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.
- C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
- D. Furnished, installed and wired under Division 20, 21, 22, and 23 unless otherwise indicated:
 - 1. Disconnected components in packaged self-contained equipment that are so constructed that components of wiring must be disconnected for shipment and reconnected after installation.

- E. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:
 - 1. Motors required for mechanical equipment
 - 2. Packaged Self-Contained Equipment:
 - a. Provide equipment ready to accept a single electrical service connection.
 - b. For equipment with remote mounted control panels, provide mounting of the control panel and external wiring from the control panel to the package self-contained equipment.
 - 3. Variable frequency controllers.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 10 percent of each fuse type and size, but no fewer than 3 of each type and size.
 - 2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products by one of the following:
 - 1. Dayton.
 - 2. Toshiba Intl.
 - 3. Baldor Electric/Reliance.
 - 4. Rockwell Automation/Allen-Bradley.
 - 5. Nidec Motor Corporation; U.S. Electrical Motors.
 - 6. Regal Beloit/GE Commercial Motors.
 - 7. Regal Beloit/Leeson.
 - 8. Regal Beloit/Marathon.
 - 9. Siemens.

2.2 MOTOR REQUIREMENTS

- A. Motor requirements apply to factory-installed and field-installed motors except as follows:
 - 1. Different ratings, performance, or characteristics for a motor are specified in another Section.
 - 2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.

3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.

- B. Electrical Power Supply Characteristics: Coordinate electrical system requirements with Division 26.
- C. Electrical Power System Characteristics: As scheduled on the Drawings.
- D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

- A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.
- B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.
- C. Frequency Rating: 60 Hz.
- D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.
- E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
- F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.
- G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
- H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.
- I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Fire pump motors, C-face motors, JP and JM frame motors, and motors over 200 horsepower shall be energy efficient motors. Efficiency of the motor shall be determined based on the NEMA MG1. The minimum efficiencies, nominal efficiencies and shall meet or exceed Table 12-11.

HP	1800 RPM OPEN DRIP-PROOF MOTORS 4 POLE		1800 RPM ENCLOSED MOTORS 4 POLE	
	NOMINAL	MINIMUM	NOMINAL	MINIMUM
	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>
1	82.5	81.5	82.5	81.5
1.5	84	82.5	84	82.5
2	84	82.5	84	82.5
3	86.5	85.5	87.5	86.5
5	87.5	86.5	87.5	86.5
7.5	88.5	87.5	89.5	88.5
10	89.5	88.5	89.5	88.5
15	91	90.2	91	90.2

1800 RPM
OPEN DRIP-PROOF MOTORS
4 POLE

1800 RPM
ENCLOSED MOTORS
4 POLE

<u>HP</u>	NOMINAL	MINIMUM	NOMINAL	MINIMUM
	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>
20	91	90.2	91	90.2
25	91.7	91	92.4	91.7
30	92.4	91.7	92.4	91.7
40	93	92.4	93	92.4
50	93	92.4	93	93
60	93.6	93	93.6	93
75	94.1	93.6	94.1	93.6
100	94.1	93.6	94.5	94.1
125	94.5	94.1	94.5	94.1
150	95	94.5	95	94.5
200	95	94.5	95	94.5

1200 RPM
OPEN DRIP-PROOF
MOTORS
6 POLE

3600 RPM
OPEN DRIPPROOF
MOTORS
2 POLE

<u>HP</u>	NOMINAL	MINIMUM	NOMINAL	MINIMUM
	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>	<u>EFF</u>
1	80	78.5	--	--
1.5	84	82.5	82.5	81.5
2	85.5	84	84	82.5
3	86.5	85.5	84	82.5
5	87.5	86.5	85.5	84
7.5	88.5	87.5	85.5	86.5
10	90.2	89.5	88.5	87.5
15	90.2	89.5	89.5	88.5
20	91	90.2	90.2	89.5
25	91.7	91	91	90.2
30	92.4	91.7	91	90.2
40	93	92.4	91.7	91
50	93	93	92.4	91.7
60	93.6	93	93	92.4
75	93.6	93	93	92.4
100	94.1	93.6	93	92.4
125	94.1	93.6	93.6	93
150	94.5	94.1	93.6	93
200	94.5	94.1	94.5	94.1

- C. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated 600 Volts or Less (Random Wound)

HP	Open Drip-Proof			Totally Enclosed Fan-Cooled		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5
5	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10	91.7	91.7	89.5	91.0	91.7	90.2
15	91.7	93.0	90.2	91.7	92.4	91.0
20	92.4	93.0	91.0	91.7	93.0	91.0
25	93.0	93.6	91.7	93.0	93.6	91.7
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	94.1
125	95.0	95.4	94.1	95.0	95.4	95.0
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	95.0	95.8	96.2	95.4

Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated Medium Volts for 5kV or Less (Form Wound)

HP	Open Drip-Proof			Totally Enclosed Fan-Cooled		
	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>	<u>6-pole</u>	<u>4-pole</u>	<u>2-pole</u>
250	95.0	95.0	94.5	95.0	95.0	95.0
300	95.0	95.0	94.5	95.0	95.0	95.0
350	95.0	95.0	94.5	95.0	95.0	95.0
400	95.0	95.0	94.5	95.0	95.0	95.0
450	95.0	95.0	94.5	95.0	95.0	95.0
500	95.0	95.0	94.5	95.0	95.0	95.0

- D. Stator: Copper windings, unless otherwise indicated.
1. Multispeed motors shall have separate winding for each speed.
- E. Rotor: Squirrel cage, unless otherwise indicated.
- F. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V- belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- G. Temperature Rise: Match insulation rating, unless otherwise indicated.
- H. Insulation: Class F, unless otherwise indicated.
- I. Code Letter Designation:

1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
 2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.
- J. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
1. Finish: Gray enamel.
- K. Sound Level: Not to exceed NEMA MG-1 12.54.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
- C. Shaft Grounding: Provide a means to protect motor from common mode currents.
1. Required for:
 - a. Motors used with variable frequency controllers.
 - b. Motors 100 HP and larger.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Electro Static Technology, Inc.; Aegis SGR Conductive Microfiber.
- D. Severe-Duty Motors: Totally enclosed, with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings insulated with nonhygroscopic material.
1. Finish: Chemical-resistant paint over corrosion-resistant primer.
- E. Source Quality Control: Perform the following tests on each motor according to NEMA MG 1:
1. Measure winding resistance.
 2. Read no-load current and speed at rated voltage and frequency.
 3. Measure locked rotor current at rated frequency.
 4. Perform high-potential test.

2.6 SINGLE-PHASE MOTORS

- A. Type: One of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.

2. Split-phase start, capacitor run.
 3. Capacitor start, capacitor run.
- B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.
- C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

2.7 ENCLOSED CONTROLLERS

- A. Provide enclosed controllers in accordance with requirements specified in Division 26 Section "Enclosed Controllers".

2.8 ENCLOSED SWITCHES AND CIRCUIT BREAKERS

- A. Provide enclosed switches and circuit breakers in accordance with requirements specified in Division 26 Section "Enclosed Switches and Circuit Breakers".

2.9 FUSES

- A. Provide fuses in accordance with requirements specified in Division 26 Section "Fuses".

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.
- B. Prepare for acceptance tests as follows:
1. Check motor nameplates for horsepower, speed, phase and voltage.
 2. Check coupling alignment and shaft end play.
 3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
 4. Test interlocks and control features for proper operation.
 5. Verify that current in each phase is within nameplate rating.
- C. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
- D. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
- E. Testing: Perform the following field quality-control testing:
1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.

2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

****END OF SECTION****

MECHANICAL VIBRATION CONTROLS

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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.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."

1.2 SUBMITTALS

- A. Product Data: Include load deflection curves for each vibration isolation device.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
 - 3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
- C. Welding certificates.

1.3 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. Installation of these items is specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATION EQUIPMENT BASES

- A. **Type A:** Direct Isolator Attachment

1. Unit to be isolated is so constructed that vibration isolators of the type specified may be directly attached, provided that the edge deflection of the isolated unit base over unsupported span between mountings does not exceed specified or manufacturer's limits. If units to be isolated will not meet required deflection provisions, Type B bases shall be provided.

- B. **Type B:** Factory-fabricated, welded, structural-steel bases or rails.

1. Structural Steel Bases:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WF or a comparable product by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.
- 3) Korfund Dynamics; a VMC Group Company.
- 4) Vibration Eliminator Co., Inc.
- 5) Vibration Isolation Co., Inc. (Pump Bases Only)
- 6) Vibration Mountings & Controls; a VMC Group Company.
- 7) Vibro-Acoustics.

- b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.

- c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

- d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

2. Structural-Steel Rails:

- a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ICS or a comparable product by one of the following:

- 1) Amber/Booth; a VMC Group Company.
- 2) Kinetics Noise Control, Inc.

- 3) Korfund Dynamics; a VMC Group Company.
 - 4) Vibration Eliminator Co., Inc.
 - 5) Vibration Isolation Co., Inc. (Pump Bases Only)
 - 6) Vibration Mountings & Controls; a VMC Group Company.
 - 7) Vibro-Acoustics.
- b. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
 - c. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - d. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. **Type C** Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type BMK/KSL or a comparable product by one of the following:
 - 1) Amber/Booth; a VMC Group Company.
 - 2) Kinetics Noise Control, Inc.
 - 3) Korfund Dynamics; a VMC Group Company.
 - 4) Vibration Eliminator Co., Inc.
 - 5) Vibration Isolation Co., Inc. (Pump Bases Only)
 - 6) Vibration Mountings & Controls; a VMC Group Company.
 - 7) Vibro-Acoustics.
 2. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
 3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 4. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.
- D. **Type D** Curb Mounted Aluminum Bases:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type CMAB or a comparable product by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. ThyCurb/Thybar.
 - c. Vibro-Acoustics.
 2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

3. Upper Frame: Corrosion resistant extruded aluminum. Upper frame shall overlap lower frame for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
4. Lower Frame: Corrosion resistant extruded aluminum. Lower framed shall overlap roof curb for water runoff. Mitered ends heliarc welded to prevent water leakage through corners.
5. Safety Stops: Neoprene, mounted in corners of lower frame for extreme wind conditions and mild seismic disturbances under normal conditions.
6. Isolators: Cadmium plated free-standing springs with positive spring retainer and flexible ties.
7. Splicing Kit: Required for bases shipped in multiple pieces.
8. Weatherseal: Flexible frictionless EPDM.
9. Static Deflection: Nominal 1 inch.

E. **Type E** Rooftop Spring Curb:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type RSC or a comparable product by one of the following:
 - a. Kinetics Noise Control, Inc.
 - b. ThyCurb/Thybar.
 - c. Vibro-Acoustics.
2. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment; and to withstand wind forces as required by local codes.
3. Lower Support Assembly: Sheet-metal "Z" section containing adjustable and removable steel springs that support upper floating frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist wind forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.
4. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
 - a. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with restraint.
 - 1) Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.
 - 2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 4) Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

- 5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- b. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1) Material: Bridge-bearing neoprene, complying with AASHTO M 251.
 - 2) Durometer Rating: 40.
5. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
6. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.
7. Sound Isolation: Within perimeter of roof curb rails and as detailed on the Drawings:
 - a. Two layers of 2-inch thick board insulation, minimum 3-lb/cu. ft. density, glass fibers bonded with a thermosetting resin. Comply with ASTM C 612 Type IA or Type IB.
 - b. Two layers of 5/8-inch thick water-resistant gypsum core wall panel surfaced with paper on front, back, and long edges. Comply with ASTM C 1396.
 - c. One layer of 6-inch thick fiberglass blanket insulation.
8. Static Deflection: Nominal 1 inch, 2 inches, or 3 inches.

2.2 VIBRATION ISOLATORS

- A. **Type 1a** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, arranged in single or multiple layers (maximum 3 layers separated by steel shims) to achieve 90 percent efficiency, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type W, Super W, WSW, and WSWSW or comparable products by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.
 2. Material: Standard neoprene for indoor applications.
 3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- B. **Type 1b** Elastomeric Isolator Pads: Oil- and water-resistant elastomer, single layer, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and 1/4 inch steel load bearing plate. Factory cut to sizes that match requirements of supported equipment.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type Super WMSW and MBSW or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
 2. Material: Standard neoprene for indoor applications.
 3. Material: Bridge-bearing neoprene, complying with AASHTO M 251 for outdoor applications.
- C. **Type 2** Elastomeric Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type ND or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
 2. Durometer Rating: Selected for maximum possible static deflection with the loading of each piece of equipment.
 3. Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.
 4. Neoprene: Bridge-bearing neoprene as defined by AASHTO.
- D. **Type 3** Spring Isolators: Freestanding, open-spring isolators.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type SLF or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 100 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. **Type 4** Restrained Spring Isolators: Restrained single and multiple spring mounts.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Types SLR and SLRS or comparable products by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
2. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

F. **Type 5** Thrust Restraints

1. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression or tension as required, and with a load stop. Include rod and angle-iron brackets with back-up plates for attaching to equipment and ductwork.
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type WBI for fan inlet connections, and Type WBD for fan outlet connections, or comparable products by one of the following:
 - 1) Amber/Booth; a VMC Group Company..
 - 2) Kinetics Noise Control, Inc.
 - 3) Korfund Dynamics; a VMC Group Company.
 - 4) Vibration Eliminator Co., Inc.
 - 5) Vibration Mountings & Controls; a VMC Group Company..
 - 6) Vibro-Acoustics.
 - b. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

- c. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- d. Minimum Additional Travel: 50 percent of the required deflection at rated load.
- e. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
- f. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- g. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- h. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.3 VIBRATION ISOLATION HANGERS

- A. **Type 8a** Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type 30N or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company..
 - f. Vibro-Acoustics.
 - 2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - 5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- B. **Type 8b** Spring Hangers with Vertical-Limit Stop: Precompressed combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries, Inc.; Type PC30N or a comparable product by one of the following:
 - a. Amber/Booth; a VMC Group Company..
 - b. Kinetics Noise Control, Inc.
 - c. Korfund Dynamics; a VMC Group Company.
 - d. Vibration Eliminator Co., Inc.
 - e. Vibration Mountings & Controls; a VMC Group Company.
 - f. Vibro-Acoustics.

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install roof curbs, equipment supports, and roof penetrations as specified in Division 07 Section "Roof Accessories."
- B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

3.3 APPLICATION

- A. Refer to Vibration Isolator Application Schedule on the drawings for isolator application and minimum deflection.

3.4 CONNECTIONS

- A. Provide flexible electrical connections in the form of large radius, 360 degree loop of flexible conduit for all vibrating isolated equipment. Any cooling water lines, compressed air, or other piping services (except inlet and outlet water connections for pumps, chillers or cooling tower) shall be made with 360 degree loops of reinforced neoprene hose, which are attached using nipples of appropriate gender. All service connections made with neoprene hose shall have shut-off valves between the hose and the supply service.
- B. Vibration isolate piping connected to vibration isolated equipment using Type 8a or 8b spring hangers, and with distance to be isolated as scheduled on the Drawings. Maximum spacing between isolators same as maximum distance between pipe hangers and supports.
- C. Vibration isolate ductwork connected to air handling units, return air fans, and vibration isolated equipment using Type 8a or 8b spring hangers, and in accordance with isolation distances scheduled on the Drawings.

3.5 EQUIPMENT BASES

- A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.
 - 1. Cast-in-place concrete materials and placement requirements are specified in Division 03.
- B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.6 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. Isolator deflection.
 - 2. Snubber minimum clearances.

3.7 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's written recommendations.

3.8 CLEANING

- A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

****END OF SECTION****

VARIABLE FREQUENCY CONTROLLERS

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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 work of this section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 REFERENCES

- A. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
- D. ANSI/NEMA MG 1 - Motors and Generators.
- E. ANSI/NFPA 70 - National Electrical Code.
- F. IEEE 519 (1992) - Applicability to Adjustable Frequency Controllers.

1.3 DEFINITIONS

- A. BAS: Building automation system.

- B. EMI: Electromagnetic interference.
- C. LED: Light-emitting diode.
- D. RFI: Radio-frequency interference.
- E. THD: Total harmonic disturbance.
- F. VFC: Variable frequency controller. Variable frequency controllers may also be referred to as variable speed drives, variable frequency drives, VSDs, or VFDs in other Specification Sections or on the Drawings.

1.4 SUBMITTALS

- A. Submit under provisions of Division 20 Section "Mechanical General Requirements" and as supplemented in this section.
- B. Submit for review, drawings indicating power, control and instrument wiring including ladder diagrams for field work as well as factory assembled work. Manufacturer's drawings are acceptable only when modified and supplemented to reflect project conditions. The drawings shall include:
 - 1. Overall schematic (elementary) diagram in JIC form of the entire system of power and control circuitry. Indicate interfaces with control wiring by temperature controls contractor.
 - 2. Wiring diagrams showing the wiring layout of component assemblies or systems.
 - 3. Interconnection wiring diagrams showing terminations of interconnecting conductors between component assemblies, systems, control devices, and control panels complete with conductor identification, number of conductors, conductor and conduit size.
 - 4. Sequence of operation for components, assemblies or systems.
 - 5. Dimensional data.
- C. Shop drawings for motor-driven equipment shall be accompanied by complete information concerning the respective motors including the following.
 - 1. Principal dimensions.
 - 2. Weights.
 - 3. Horsepower.
 - 4. Voltage, phase, frequency.
 - 5. Speed.
 - 6. Class of insulation.
 - 7. Enclosure type.
 - 8. Frame.
 - 9. Bearings including AFBMA Rating Life (L-10 basis).

10. Design letter.

11. Manufacturer.

12. Service Factor

- D. Descriptive data shall include catalogues, guaranteed performance data with efficiency and power factor indicated at 75 percent and 100 percent of rated load and verification of conformance with other requirements of the Contract Documents. The information enumerated under NEMA MG1 Paragraph MG1-10.38, shall be arranged on one sheet for each motor.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

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

- C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 COORDINATION

- A. Coordinate with temperature controls contractor for interfaces with temperature controls wiring.

1.8 WARRANTY

- A. Warranty shall be 36 months from date of project acceptance. The warranty shall include all parts, labor, travel time and expenses.

PART 2 - PRODUCTS

2.1 GENERAL

- A. For Electrical Work Provided under Division 20, 21, 22, and 23 Specifications: Furnish UL Listed components, in accordance with Division 26 Specifications and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.
- B. Electrical Power Supply Characteristics: 480 volts, 3phase, 60 hertz (Hz).
- C. Provide Electrical Work required for the operation of components and assemblies provided as part of the Work under Division 20, 21, 22, and 23 Specifications.
- D. Mount line voltage (120 VAC) control components specified as part of the Work under Division 20, 21, 22, and 23 Specifications.
- E. Refer to ELECTRICAL DRAWINGS and Division 26 Specifications for specified information regarding provisions for the arrangement of electrical circuits and components and for interface with Work specified under Division 20, 21, 22, and 23 Specifications.

- F. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.
- G. Electrical testing of motors is specified as part of the Work under Division 26 Specifications.
- H. The mechanical contractor shall furnish and install the variable frequency controller. Electrical trades shall make power connections to both load and line side of the VFC.

2.2 MOTORS

- A. Refer to Division 20 Section "Motors."

2.3 VARIABLE FREQUENCY CONTROLLERS

- A. Variable Frequency Controller Manufacturers:
 - 1. A.B.B.
 - 2. Danfoss.
 - 3. Eaton (Cutler-Hammer).
 - 4. General Electric.
 - 5. Hitachi.
 - 6. Johnson Controls Incorporated (Private labeled A.B.B.).
 - 7. Mitsubishi Electric Automation, Inc
 - 8. Square D.
 - 9. Toshiba International Corporation.
 - 10. Yaskawa Electric America, Inc.
- B. Provide variable frequency controllers as scheduled including bypass starter, coasting motor restart, and step over frequency.
 - 1. The ratio of the total impedance to common system impedance shall be greater than or equal to 10.
 - 2. The voltage notch area shall be limited to 16-400 volt microseconds.
 - 3. The total harmonic disturbance (THD) as a result of voltage notching shall be 3 percent or less at the point of common coupling.
 - 4. The THD as a result of current notching shall be 100 percent or less at the point of common coupling.
- C. Standards: VFC shall comply with IEEE Standard 519 (1992 version) applicability to Adjustable Frequency Controllers (AC Line Disturbances).

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- D. Provide 3 percent AC input line reactors sized appropriate for each current rating variable frequency controller.
- E. The variable frequency controller (VFC) shall comply with all applicable provisions of the National Electrical Code.
- F. The line side of the VFC shall have a displacement power factor of 0.95 or greater when motor is operating at 50 to 100 percent motor speed.
- G. The VFC shall have an efficiency greater than 85 percent when motor is operating at 50 to 100 percent motor speed.
- H. Each variable frequency controller shall consist of an adjustable frequency converter which shall convert 460 volt (+10 percent -5 percent), 3-phase, 60 hertz (+2 hertz) input power into an adjustable frequency output in an ambient temperature of zero to 40 deg C. Output power shall be of suitable capacity and waveform to provide stepless speed control of the specified horsepower motor throughout the required speed range under variable torque load not exceeding the motor's full-load rating.
- I. Provide fault detection and trip circuits to protect itself and the connected motor against line voltage transients, power line under voltage, output overvoltage and overcurrent. A disconnect with padlockable door interlocked external handle shall be supplied to conveniently disconnect the incoming 460 VAC. Minimum short circuit design shall be 42,000 amperes symmetrical. Criteria in Paragraph B shall be met without the use of isolation transformers. Variable frequency controller will be accepted only if criteria can be met without isolation transformers.
- J. The minimum output frequency shall be the lowest frequency at which the connected motor can be operated without overheating.
- K. The inverter shall contain current limiting circuitry, adjustable to 100 percent of motor full-load current to provide soft start, acceleration, and running without exceeding motor rated current. The current limit circuit shall be of the type for variable torque load, which acts to diminish output frequency while limiting, without directly causing shutdown.
- L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts. For safety, drive shall shut down and require manual reset and restart if automatic reset/restart function is not successful within three attempts.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Isolate signal circuits from the power circuits and design to accept a speed signal from a remote process controller in the automatic mode and from the speed control potentiometer in the manual mode. A door-mounted switch shall provide mode selection. The selected signal shall control the motor speed between the adjustable minimum and maximum speed settings. Maximum speed shall be field adjustable to 100 percent of rated speed. The speed signal shall follow a linear time ramp, adjustable from 4-20 seconds to provide acceleration from zero to minimum speed. When minimum speed is reached, the speed signal shall follow the linear time ramp for acceleration and deceleration control.
- O. Mount the adjustable frequency inverter and other electrical components that provide the operation specified in a NEMA12 enclosure. Equipment shall have external heat sinks or air filters on all vents. The enclosure shall have hinged, front access doors with latch. Cabinet to cabinet

interconnecting wiring shall be factory dressed, tagged and harnessed, and shipped with one end attached.

- P. The controller shall have the ability to step-over certain set frequencies that may cause a system to resonate. The controller shall have at least two manually set points of frequency in which the controller shall step-over during operation.
- Q. Operating and monitoring devices for the inverter shall be door mounted and shall include the following:
1. Manual Speed Control to set speed in the hand (manual) mode.
 2. Speed indicating meter, either in revolutions per minute, proportional to the applied frequency and voltage to indicate speed of the converter-powered motor or frequency (hertz).
 3. VFC "fault/reset" pilot light pushbutton combination with dry contact for external alarm. Fault alarm shall not actuate upon normal shutdown.
 4. Inverter "control power" indicator.
 5. Motor "running" indicator and two (2) dry contacts that close when motor is running.
 6. Output current meter calibrated in "AC amps."
 7. Operating selector switches and indicating light to perform the following functions:
 - a. One hand-off-auto switch for the VFC and bypass starter with indicating lights (red-running, green-energized). In hand position, unit (VFC or bypass starter) shall start. In auto position, unit (VFC or bypass starter) shall start when remote dry contact is closed.
 - b. Unit shall be capable of being padlocked in the off position.
 - c. Variable frequency bypass selector switch with indicating lights. In bypass position, contactors and interlocks shall be positioned to run unit directly from 460 VAC line voltage when the H-O-A selector switch is in hand or auto position.
 8. Output voltmeter (0 - 600 V.A.C) (analog or digital).
- R. The VFC is to be provided with isolated 4-20 mA DC output signals proportional to speed, current and voltage for connection by others.
- S. The VFC shall be provided with the ability to communicate (monitoring) through RS485 connector.
- T. Remote speed control shall be a 3-15 psig pneumatic signal from a remote controller. Provide a pressure transducer in the VFC enclosure to convert the pneumatic signal to an electrical signal for automatic speed control.
- U. Remote speed control shall be +4 to 20 mA control signal from a remote controller.
- V. Automatic bypass starter shall be as follows:
1. Single-Speed Nonreversing Starter: Consisting of a full voltage magnetic starter with two (2) convertible auxiliary contacts, thermal overloads, control transformer and control devices as indicated and as specified, all mounted and wired in a separate sectioned part of VFC enclosure.

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2. Interlocking: Equip switch with an external operating handle. Interlock the operating handle such that the door cannot be opened unless the switch is in the "off" position. Provide means for padlocking the operating handle in the "off" position with three 5/16 inch shackle padlocks such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch cannot be closed.
 3. Starter: Size starters per the horsepower of the motors with which they will be used, except do not furnish starters smaller than NEMA Size 1 for motors of 5 horsepower or less. Provide coils for operation on 120 volts AC unless other requirements are indicated. Equip each starter with a minimum of two convertible auxiliary contacts in addition to the normally-open seal-in contact, unless additional requirements are indicated. Provide additional contacts as indicated.
 4. Thermal Overload: One in each phase wire, manual reset type. Select overloads after final installed horsepower of motor is determined. Do not use ratings exceeding 100 percent of motor full load current adjusted for ambient temperatures.
 5. Control Transformer: Provide a 480-120 volt control transformer in the starter enclosure. Fuse and ground the secondary winding as indicated. Where indicating lights or other control components are to be energized from the control transformer, increase the capacity of the control transformer to 200 VA.
 6. Bypass/VFC starter shall consist of 3 contactors or have a drive disconnect as well as a main disconnect for isolation purposes.
- W. Variable frequency controller shall not cause motor to produce noise levels exceeding 80 dBA measured at a distance of 3 feet from the motor. If noise level of motor exceeds this amount, the contractor shall be responsible for correcting the problem.
- X. Provide connection points for system safety controls such as smoke detectors, freeze stats, damper end switches, etc. as shown on mechanical temperature control drawings. Opening of a contact on safety controls wired to the drive shall shut down the motor(s) in both the VFC and bypass mode.
- Y. VFCs specified on the drawings to have contactor motor selection, in order to operate "either one or both" motors connected to the VFC, shall have the separate motors controlled by horse power rated contactors. These contactors shall be capable of being controlled locally (by a switch in the panel door) or remotely. The contactors shall also have two (2) convertible auxiliary contacts in order to sense contactor position.
- Z. Provide in each VFC, a relay, that upon loss of the automatic speed control signal, shall automatically switch the unit to bypass mode.
- AA. Coordinate with the Temperature Controls Contractor for the interface of control wiring to the drive as required to meet the requirements of the temperature control drawings. Drive shall be furnished with internal control wiring configured in the factory so as to allow single connections of field wiring to terminal blocks in the drive by the Temperature Controls Contractor.
- BB. All indicating lights shall be push to test or LED.
- 2.4 SOURCE QUALITY CONTROL
- A. Factory Tests: The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
2. All printed circuit boards shall be tested at 50 deg C for 50 hours. The VFC manufacturer shall provide certification that the tests have been completed.
3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install and adjust materials and equipment in accordance with the manufacturer's instructions.
- B. Obtain the manufacturer's instructions for materials and equipment provided under the Contract in detail necessary to comply with the requirements of the Contract Documents.
- C. If unit is free standing, provide a concrete housekeeping pad.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Upon completion of each installation, conduct complete acceptance tests in the presence of duly notified authorities having jurisdiction and the Owner to demonstrate component, assembly or system performance in accordance with the requirements of the Contract Documents.
- C. In the event that a test demonstrates that a component assembly or system performance is deficient, the Owner may require additional tests after corrective work.
- D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
- E. Component assembly and systems acceptance is predicated upon completion of specified work and receipt by the Owner of data specified under "Submittals."

3.4 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.
- E. Set field-adjustable circuit-breaker trip ranges.
- F. Set field-adjustable pressure switches.

3.5 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.6 DEMONSTRATION

- A. The VFC supplier/support group shall provide the following additional services:
 - 1. On-site training of customer personnel in operation and maintenance of variable frequency controllers.
 - 2. Provide four copies of a troubleshooting manual and factory training manuals to help the building operator determine what steps must be taken to correct any problem that may exist in the system.
 - 3. Coordinate enrollment of customer personnel in factory-held service schools.

****END OF SECTION****

COMMON WORK RESULTS FOR HVAC

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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.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."
 - 3. Division 23 Section "Testing, Adjusting, and Balancing."

1.2 SUMMARY

- A. This Section includes common requirements for fans and air moving equipment.

1.3 SUBMITTALS

- A. Product Data: For the following:
 - 1. Fan bearings.
 - 2. V-belt fan drives.

3. Direct drive couplings.

1.4 QUALITY ASSURANCE

- A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- B. Fan Performance Data: AMCA Standard 210.
- C. Sound Power Level Ratings:
 1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
 2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FAN SHAFTS

- A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FAN POWER TRANSMISSION

- A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.
- B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.
- C. Base horsepower rating of drive on minimum pitch diameter of small sheave.
- D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.
- E. Adjust belt tension in accordance with the manufacturer's recommendations.
- F. Perform alignment and final belt tensioning in the presence of the Architect.

2.4 SHEAVES

- A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.
- B. For all constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.
- C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.
- D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.
- E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.
- F. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.5 V-BELT FAN DRIVES

- A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.
- B. Manufacturers:
 - 1. Emerson Power Transmission; Browning.
 - 2. Rockwell Automation; Dodge.
 - 3. T.B. Wood's Incorporated.

2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

- A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.
- B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.
- C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.
- D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for

shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.

- E. Centrifugal exhaust fans shall be provided with shaft seals.

2.7 BELT DRIVE GUARDS

- A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.
- B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.

2.8 V-BELTS

- A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.
- B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.
- C. Manufacturers:
 - 1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
 - 2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
 - 3. T.B. Wood's Incorporated; Classical Cog and Narrow Cog V-Belts.

2.9 V-BELT DRIVE MOTOR BASES

- A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.
- B. Provide for adjustment of both belt tension and alignment.

2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

- A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.
- B. Provide sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each existing air handling system requiring rebalancing during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

- A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.
- B. Manufacturer:
 - 1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

- A. Furnish motors in accordance with Division 20 Section "Motors."

2.13 FAN BEARINGS

- A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L₁₀ minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.
 - 1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.
 - 2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L₁₀ life requirements.

2.14 IDENTIFICATION

- A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.15 ACCESSORIES

- A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.
- B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.
- C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION

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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 work of this section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 23 Section "Common Work Results for HVAC" for common mechanical drive requirements for fans and air moving equipment.
 - 3. Division 23 Section "Heating and Cooling Coils."

1.2 REFERENCES

- A. Standards referenced in this Section:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
 - 3. AMCA 99 - Standards Handbook.
 - 4. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

5. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
6. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
7. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
8. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils.
9. ANSI/AHRI 430 – Central Station Air Handling Units.
10. ANSI/AHRI 440 – Performance Rating of Room Fan-Coils.
11. NEMA MG1 - Motors and Generators.
12. NFPA 70 - National Electrical Code.
13. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
14. ANSI/UL 586 - Test Performance of High Efficiency Particulate Air Filter Units.
15. ANSI/UL 900 - Test Performance of Air Filter Units.
16. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
17. MIL-STD-282 - Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods.
18. UL Standard 1995 – Standard for Heating and Cooling Equipment.

1.3 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Filters: Filter performance data, filter assembly, and filter frames.
- C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 3. Wiring Diagrams: Power, signal, and control wiring.
- D. Field quality-control test reports.
- E. Start-up reports.
- F. Operation and Maintenance Data: For environmental equipment to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Air handling units shall be ETL listed to UL Standard 1995.
- B. Filters:
 - 1. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.
 - 2. Provide all filters as product of one manufacturer.
 - 3. Assemble filter components to form filter banks from products of one manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- D. Protect coils from entry of dirt and debris with pipe caps or plugs.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.7 EXTRA MATERIALS

- A. Provide one set of fan belts for each fan.
- B. Provide one additional set of each filter type for each unit, to be installed at project closeout.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL DOUBLE AND SINGLE WIDTH FANS

- A. Centrifugal double and single width fans shall include housing, wheel, fan shaft, fan shaft seals, bearings and side support structure in arrangement as indicated on drawings. Fans shall be air foil, backward inclined or forward curved as indicated on drawings. Air foil and backward inclined fans shall be non-overloading type. Select fans to avoid instability in service and compute outlet areas to outlet velocities per AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency. After mounting in cabinet, balance fan wheels on shafts supported pillow blocks mounted on the cabinet.
- B. Fan scrolls shall have bolted or continuously welded construction and shall be rigidly braced to prevent vibration. Metal thickness of the wheels, scroll, and side sheets shall not be less than that specified by the AMCA for the class of service.
- C. Fan inlet cones shall be streamline design, bolted to fan housing to allow for wheel removal. Bearing pedestals shall be carried to the main structural framework. Fans shall carry the AMCA rating seal.

- D. Where there are duct connections to fan inlets and outlets, provide frames or flanges for duct attachment. Fans shall be prime and finish painted on all interior and exterior surfaces with approved corrosion inhibiting enamel.
- E. Hinged access doors shall be provided for fans larger than 18 inches in diameter and shall be located in the lower section of the fan scroll.
- F. Vibration isolation provisions shall be as specified in Division 20 Section "Mechanical Vibration Controls."
- G. Manufacturers:
 - 1. Buffalo Forge Co.
 - 2. Trane.
 - 3. Acme.
 - 4. Aerovent; a Twin City Fan Company.
 - 5. Twin City.
 - 6. Chicago Blower.
 - 7. Greenheck.
 - 8. Loren Cook.
 - 9. PennBarry.

2.2 PLENUM/PLUG FANS

- A. General: Select fans to avoid instability in service and compute outlet areas to outlet velocities in accordance with AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency.
- B. Description: AMCA certified, factory-fabricated, -assembled, -tested, and -finished, belt-driven, unhooded centrifugal plenum/plug fans consisting of wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- C. Motors: Comply with requirements in Division 20 Section "Motors."
- D. Manufacturers:
 - 1. Acme Engineering & Mfg. Corp.
 - 2. Aerovent; a Twin City Fan Company.
 - 3. PennBarry.
 - 4. Chicago Blower Corporation.
 - 5. Loren Cook Company.
 - 6. Trane.

7. Twin City Fan & Blower; a Twin City Fan Company.
8. Howden Buffalo; Buffalo Forge.

2.3 CENTRAL STATION AIR HANDLING UNITS

A. General:

1. Furnish central station type air handling units, factory fabricated and sectionally or fully assembled, including components and auxiliaries as indicated and specified elsewhere herein, and classified and defined, as applicable, under ANSI/ARI Standard 430-2009.
2. Performance test and rate air handling unit and components, where applicable, per AMCA Bulletin 203 except as otherwise specified. Provide air handling ratings in accordance with ANSI/AHRI 430 and classify total static pressure in accordance with AMCA Standard 1401.
3. Furnish DWDI centrifugal scroll type fan as specified. Confirm unit components to be included and edit appropriately.
4. Provide components including but not limited to: Piping, hot water heating coils, cooling coils, dampers, fan, motors, drives, filters, blank/access sections, thermal insulation and dampers, as specified.
5. Fans:
 - a. Fans, located within cabinets of packaged central station air handling equipment shall be backward curved, air foil or forward curved centrifugal scroll type as indicated on the drawings. Determine catalogued capacity with fan installed within fan-section cabinet. Backward inclined and air foil type shall be non-overloading type. Select fans to avoid instability in service and compute outlet areas to outlet velocities per AMCA Standards. Maintain fan duty point to the right of the peak static pressure point farthest from shut-off and at approximately 60 percent overall efficiency. After mounting in cabinet, balance fan wheels on shafts supported by pillow blocks mounted on the cabinet. Fit draw-through fan scroll with drainage provisions from lowest point for moisture disposal.
 - b. Fan scrolls shall have bolted or continuously welded construction and shall be rigidly braced to prevent vibration. Metal thickness of the wheels, scroll, and side sheets shall not be less than that specified by the AMCA for the class of service. Fan inlet cones shall be streamline design, bolted to fan housing to allow for wheel removal. Bearing pedestals shall be carried to the main structural framework. Fans shall carry the AMCA rating seal.
 - c. Where there are duct connections to fan inlets and outlets, provide frames or flanges for duct attachment.

B. Materials and Construction:

1. Fabricate enclosure from mill galvanized carbon steel or aluminum sheet, and finish with manufacturer's standard painting system.
2. Construct unit cabinet suitable for AMCA Class A pressure with leaktight joints, closures, penetrations and access provisions. Seal joints between cabinet sections and between exterior panels and structural frames with closed-cell foam gasketing for leak seal and for thermal/acoustical break.
3. Construct cabinet so as not to expand or contract perceptibly during starting and stopping of fan and not to pulsate during operation. Stiffen pulsating panels which produce low frequency

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noise due to diaphragming of unstable panel walls to raise natural frequency to an easily attenuated level.

4. All sections of the central station air handling unit cabinet including coil segments shall be 2-inch double-wall construction with solid inner and outer panels. Insulation between panels shall be 2 inches thick with characteristics specified below.
5. Where man access is possible, strengthen floor to permit entry without damage to any part. Provide access doors and size as large as unit will permit. Reinforce access doors and panels with mill rolled structural steel if necessary and hinge and latch doors at a spacing sufficiently close to preclude leaks caused by distortion. Effectively gasket the door and furnish latches operable from either side of man access plenums. Door swing shall be such that the door is held shut by normal system operating pressure.
6. Extend integral IAQ compliant drain pan under all areas where condensate collects. Fabricate of AISI Type 304 stainless steel watertight with welded or brazed joints piped to drain, and insulated against sweating. Enclose and factory insulate cooling coil ends against sweating or drain to drain pan.
7. Furnish intermediate IAQ compliant coil drip pans for each tiered coil bank where needed to restrict downstream carryover of condensate. Fabricate pan of minimum 22 gauge AISI Type 304 stainless steel with brazed joints and pipe bottom of pan to drain.
8. Provide all necessary piping internal to cabinet and including penetration of cabinet walls and terminal connection for piping external to cabinet. Seal cabinet penetrations air tight and protect against condensation within cabinet walls.
9. Where space within a cabinet does not allow including water seals of sufficient depth, provide seals external to the cabinet.
10. Coordinate, in sufficient time during construction, placement of drain piping external to the cabinet to safe disposal point. Do not place drain piping on floor surface unless so indicated.
11. Furnish unit, factory insulated with internally fitted sound attenuating-thermal insulating fibrous glass material with a surface deeply impregnated with chloroprene. Insulation shall be 1-1/2 lb./cu.ft. matt faced type, with thickness as specified above. Furnish insulation which precludes condensation on any exterior cabinet surface under ambient conditions of 90 deg F and 75 percent relative humidity, normal to the unit installed location. Efficiency of acoustic treatment shall be such as to effectively attenuate fan noise. Apply material to the cabinet with adhesive on a 100 percent coverage basis, welded pins and speed clips or channels. Furnish adhesive and insulating materials conforming to requirements of NFPA 90A.
12. Should any condensation occur on exterior surfaces or enclosure once system is in operation, remove any installed materials and effectively apply new materials to the affected surfaces to preclude condensation at no increase in the Contract Sum and to the satisfaction of the Architect.
13. Provide motors, fans, fan drives, unit coils, filters, power transmission, guards, air blenders and the like in conformance with requirements specified under appropriate headings in this section.
14. Provide dampers in conformance with requirements specified in Division 23 Section "Temperature Controls."

15. Units shall be factory balanced as a complete assembly to 0.2 in./sec. measured in the horizontal, vertical and axial direction at the bearings of the unit (not the motor).
16. All cabinet sections shall be installed on a six inch high (minimum) galvanized steel base rail.

C. Coils: As specified in Division 23 Section "Heating and Cooling Coils."

D. Vibration Isolation:

1. Fans, motors and drives shall be internally vibration isolated from cabinet. Provide internal vibration isolation in accordance with Division 20 Section "Mechanical Vibration Controls" requirements for centrifugal fans. Where units are not internally vibration isolated, provide external vibration isolation in accordance with Division 20 Section "Mechanical Vibration Controls" requirements for central station air handling units.

E. Manufacturers:

1. Trane.
2. JCI/York.
3. Buffalo.
4. Daikin Applied.
5. Carrier.

2.4 AIR COOLED CONDENSING UNIT

- A. Outdoor unit shall be factory assembled, charged, and tested air cooled scroll compressor condensing unit with capacities as scheduled. Unit shall be provided with two independent refrigeration circuits with service valves.
- B. Condenser coils shall be internally enhanced seamless copper tubes with aluminum fins. Design working pressure shall be 450 PSIG.
- C. Fans shall be statically and dynamically balanced, direct drive, with low noise, full airfoil section blades and fan guard.
- D. Microprocessor control center shall manufacturers standard with liquid crystal display, and programmable setpoints, and shall automatically start, stop, cycle fans, modulate unit output, and prevent short cycling of the compressors when enabled through the building automation system.
- E. Provide unit with standard outdoor ambient control, single point terminal block and non-fused disconnect, pressure and temperature transducers and sensors, control power transformer, hot gas by-pass, building automation system reset interface, and sound reduction package including low speed reduced noise fans and compressor acoustic blankets.
- F. Manufacturers
 1. Carrier.
 2. JCI/York.
 3. Daikin Applied.

4. Trane.

2.5 DISPOSABLE, EXTENDED AREA PANEL FILTERS (PRE-FILTER)

- A. Media: Pleated, non-woven cotton/polyester blend, bonded to galvanized expanded metal or welded wire grid. Media pack shall be enclosed in a heavy duty, moisture resistant beverage board frame with support members on both upstream and downstream sides. Filters shall contain not less than 5.5 square feet of media per square foot of filter face area. Filters shall be UL Listed, Class II as to flammability.
- B. Rating (unless otherwise indicated on drawings) MERV 7 in accordance with ASHRAE 52.2 (30 percent dust spot in accordance with ASHRAE 52.1), 592 fpm face velocity, 0.30 inch W.G. maximum initial resistance, 1.0 inch W.G. maximum recommended final resistance.
- C. Manufacturers:
 - 1. Eco Air; C35II.
 - 2. Filtration Group; Series 400.
 - 3. Flanders.
 - 4. Camfil Farr; 30/30.
 - 5. American Air Filter; Amair300X.

2.6 HIGH CAPACITY EXTENDED SURFACE (V-STYLE) FILTERS

- A. Media: Ultra fine synthetic media, (fiberglass media is not acceptable) pleated, totally rigid and totally disposable type. Each filter shall consist of wet-laid, high efficiency media bonded to V-bank design high-strength, impact-resistant plastic enclosing frame. Each filter shall have foam gasketing on the vertical sides of the header. Capacity, efficiency and nominal size shall be indicated on the drawings. Filters shall be UL Listed, Class II as to flammability.
- B. Rating: AHU's-MERV 14 in accordance with ASHRAE 52.2 (90-95 percent dust spot in accordance with ASHRAE 52.1), ERU's-MERV 11 in accordance with ASHRAE 52.2 (60-65 percent dust spot in accordance with ASHRAE 52.1), 500 fpm face velocity, maximum initial resistance: 0.55 inch W.G. for MERV 14, 0.25 inch W.G. for MERV 11. Maximum recommended final resistance is 1.5 inches W.G. for both.
- C. Manufacturers:
 - 1. Eco Air.
 - 2. Filtration Group.
 - 3. Flanders.
 - 4. Camfil Farr; Durafil 2V.
 - 5. American Air Filter.

2.7 FILTER GAUGES

- A. Direct Reading Dial: 3-1/2 inch diameter diaphragm actuated dial in metal case, vent valves, black figures on white background, front recalibration adjustment, range 0-2.0 inch WG, 2 percent of full scale accuracy.
- B. Manufacturer:
 - 1. Dwyer Magnehelic.
- C. Provide filter gauges across each filter bank.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Furnish, install and apply equipment and materials in accordance with the manufacturer's published instructions, and approved shop Drawings.
- B. Install central station air handling units in accordance with manufacturer's recommended procedures.
- C. Hoist, transport, and rig air handling units or their shipping sections into position following procedures recommended by the manufacturer.
- D. Replace filters in each unit at time of project final acceptance. Refer to Division 20 Section "Mechanical General Requirements" for additional information.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
 - 2. Hot-Water Heating Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Connect to supply and return coil tappings with shutoff or balancing valve and union or flange at each connection.
 - 3. Steam and Condensate Piping: Comply with applicable requirements in Division 23 Section "Steam and Condensate Piping." Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.
- D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 LUBRICATION

- A. Lubricate equipment and fill lubrication systems per manufacturer's published instructions.

3.4 FIELD QUALITY CONTROL

- A. Perform tests in accordance with manufacturer's published data.

3.5 START-UP SERVICE

- A. Provide a field Engineer for start-up of factory fabricated, built-up air handling and exhaust units. Field Engineer shall provide start-up service for temporary construction use, final inspection and adjustment of the units. Include labor, materials, travel, per diem and any other costs as part of the "Field Engineer" work.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment. Refer to Division 20 Section "Mechanical General Requirements." Provide copies of operation and maintenance manuals as specified.

****END OF SECTION****

AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

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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.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachments to other Work. For installed products indicated to comply with design loads, include structural analysis data.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain air-to-air energy recovery units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-to-air energy recovery units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

- D. ARI Compliance: Ratings for energy recovery devices shall comply with ARI 1060, "Rating Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
- E. ASHRAE Compliance:
 - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."
- F. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
- G. UL Compliance:
 - 1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.4 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: Furnish one set of each type of filter specified.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 FIXED-PLATE HEAT EXCHANGERS

- A. Manufacturers:
 - 1. Innovent Air Handling Equipment.
 - 2. Munters Corporation; Des Champs Products Division.
 - 3. Venmar CES Inc.
- B. Casing: Aluminum with duct collars.
 - 1. Insulation: 1-inch- thick, foil-faced glass fiber.

2. Drain Pan: Same material as casing, with drain connections on exhaust and supply side.
- C. Plates: Construct with plates evenly spaced, sealed and arranged for crossflow or counter airflow.
 1. Plate Material: Minimum 0.008-inch thick, 99.5 percent pure aluminum.
 2. Plate Coating: Air-dried phenolic where required for corrosive airstreams.
- D. Bypass: Construct bypass plenum within casing, with gasketed face-and-bypass dampers having operating rods extended outside casing.
- E. Accessories:
 1. Filter: 2 inches thick, disposable.
 2. Flexible Duct: UL 181, Class 1 insulated.
 3. Humidistat: Wall mounted, adjustable.
 4. Weather hoods (wall caps) with 1/4-inch bird screen and insulated flexible duct termination.

2.3 DEHUMIDIFICATION UNITS

- A. Manufacturers:
 1. Gouvernaire Corporation.
 2. Innovent Air Handling Equipment.
 3. Munters Corporation; Des Champs Products Division.
 4. Venmar CES Inc.
- B. General: Construct unit as specified. Single wall and 1-inch double wall casing are unacceptable. Fans and coils must be removable without dismantling the structural framing of the unit. Unit shall be suitable for indoor or outdoor installation as detailed on the plan drawings.
- C. Base: Construct base of minimum 10 gage welded structural steel with cross supports integral lifting lugs. Bolted bases are unacceptable. Base shall be insulated and provided with a minimum 22 gage galvanized G90 steel subfloor. Coat base with 2 part epoxy primer and urethane modified enamel top coat.
- D. Flooring: Provide double wall floor construction. Walk on floor material shall be a minimum of 0.072-inch aluminum tread plate. Flooring sheets shall be sealed with a closed-cell neoprene gasket material to minimize sound transmission to spaces located below the unit.
- E. Framing: Frame is constructed of aluminum members designed to support double-wall panels. Framing must have gasketing between support members and panels.
- F. Panels: Unit shall have non-load bearing heavy gauge 2-inch double-wall panels. Interior panels exposed to the pool air shall be constructed of aluminum or steel with a baked corrosion resistant coating.

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- G. Casing Ratings: Maximum casing panel deflection shall not exceed L/250 at 8 inches w.c. TSP (where L is the longest panel span on the unit). Casing shall meet a SMANCA duct class leakage rating of 5 at 8 inches w.c. TSP. The panel insertion loss, per octave band, shall not be less than the following:

Frequency:	<u>100</u>	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>	<u>8000</u>
Insertion loss, dB:	24	16	30	32	33	34	63	60

- H. Insulation: All interior walls, floor, and roof shall be double wall and insulated. Walls and roof are insulated with 2 lb./cu. ft. polyurethane foam insulation having an average R-value of 6 per inch. Floors shall be insulated with 1.5 lb./cu. ft. fiberglass insulation to achieve minimum R16. No insulation shall be exposed to the air stream.
- I. Coatings: Exterior casing shall be coated with 2 part epoxy primer with urethane modified enamel top coat. Galvanized exterior unacceptable if unit casing or framework is welded. Interior casing shall be aluminum or galvanized with a baked corrosion resistant coating. All steel parts exposed to the pool air shall be coated with air-dried phenolic.
- J. Access Doors: Provide double wall doors insulated with 2 lb./cu. ft. polyurethane foam. Doors shall be full height with stainless steel piano hinges, Allegis corrosion resistant compression latches (tool lockable in fan sections), and minimum 24-inch clear opening width at all walk-in sections. Supply and exhaust air streams shall not be covered by a single door. Provide doors for access to any area requiring routine maintenance. Access panels in lieu of access door are unacceptable.
- K. Door Accessories:
1. Access doors shall be provided with aluminum door tie backs.
- L. Weather hoods (for outdoor units): Provide weather hoods and bird screens over all exposed inlets and outlets. Ship hoods loose for installation in the field.
- M. Roof (for outdoor units): Provide roof with standing seam construction. Pitch roof with sufficient slope to ensure water drainage. Roof overhang to be provided around complete perimeter of the unit.
- N. Heat Recovery Device: Fixed-plate heat exchanger.
- O. Supply and Exhaust Blower: 12 blade aluminum airfoil plenum fan. Plenum fans with less than 12 blades are not acceptable due to increased noise levels. Non-airfoil blades are not acceptable due to decreased efficiency of the fan. Hi-Pro Polyester urethane powder coating or equivalent air-dried Heresite coating for corrosive environments.
- P. Refer to Division 20 Section "Motors" for general requirements.
- Q. Drives: Adjustable for 10 hp motors and smaller, fixed for 15 hp motors and larger. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.
- R. Isolation: Refer to Division 20 Section "Mechanical Vibration Controls."
- S. Accessories:
1. Variable Frequency Controllers: Provide variable frequency controller for the exhaust fan. VFC shall be factory provided and installed inside the unit behind an access door.

- a. VFC Options Required: Manual bypass. Exhaust fan VFC shall be provided with building static pressure control (sensor shipped loose for field installation).
- T. Dampers: Motorized dampers shall be low leakage type with aluminum construction, airfoil blades, vinyl edge seals, metal jamb seals, and synthetic bearings. Gravity dampers shall have aluminum frame, aluminum blades, extruded vinyl edge seals, and synthetic bearings. All dampers exposed to the pool air (exhaust damper & recirculation air damper) must be constructed of aluminum.
1. Provide the following dampers:
 - a. Outside air damper.
 - b. Outside air heat exchanger face sequencing dampers, parallel blade type, two-position actuators. A minimum of 5 dampers are provided across the face of the heat exchanger to allow defrost operation without affecting performance.
 - c. Outside air heat exchanger bypass damper, parallel blade type, 2-position actuator.
 - d. Exhaust gravity damper.
 - e. Recirculation Damper.
- U. Filters:
1. Aluminum Outside Air Filter: Provide 2-inch thick, washable aluminum filter bank in the location shown on unit drawing. Mount in galvanized steel front access rack and size for 500 fpm maximum face velocity.
 2. Aluminum Return Air Filter: Provide 2-inch thick, washable aluminum filter bank in the location shown on unit drawing. Mount in galvanized steel front access rack and size for 650 fpm maximum face velocity.
- V. Indirect Fired Duct Furnace: Indirect fired duct furnace provided with performance as specified in the schedule. Furnace shall be ETL listed using ANSI Z83.8 standards. Furnace shall have a tubular heat exchanger constructed of Type 409 stainless steel. Tubes shall have integral formed dimples to maximize heat transfer and condensate drainage. Burner assembly shall include inshot type burners, electronic spark ignition system, high temperature safety control, air proving switch, and draft inducer.
1. Allowable Gas Inlet Pressure: 6 inches to 14 inches w.c.
 2. Gas Valve: Minimum 4:1 turndown electronic modulating or turndown as scheduled, whichever is greater.
 3. Vent Pipe For Indoor Unit: Furnished and installed by the Contractor.
- W. Direct Expansion Refrigerant Coils:
1. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
 2. Minimum Working-Pressure Rating: 300 psig.
 3. Source Quality Control: Factory tested to 450 psig.
 4. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
 5. Fins: Aluminum, minimum 0.010 inch thick.

6. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.
7. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick.
- X. Hot Gas Reheat Coil: Provide ARI rated coil with 0.016-inch thick copper tubes, stainless casing, and rippled aluminum plate fin secondary surface with a thickness of 0.0075-inch.
 1. Coil: Dehydrated with 140 deg F DB/40 deg F dew point air before shipment.
 2. Source Quality Control: Tested with 315-psig air pressure under warm water and guaranteed for 250 psig working pressure.
 3. Provide coil with a three-way modulating control valve.
 4. Coils need to be epoxy coated for corrosion protection.
- Y. Integral Condensing Unit: Provide integral air cooled condensing system factory piped, wired, charged, and tested. Entire condensing section must be assembled by the unit manufacturer. Skid mounting another manufacturers condensing unit is not acceptable.
 1. Provide hermetic scroll type compressors with suction and discharge service valves, reverse rotation protection, sight glass, oil level adjustment, oil filter, rotary dirt trap, non-short cycling control, and high and low pressure limits. Lead compressor shall be digital for capacity control.
 2. Provide condenser coils with galvanized casing, seamless copper tubes, and aluminum fins.
 3. Condenser fans shall be direct drive with fan guards.
 4. Independent circuits shall be provided completely tested, dehydrated, and fully charged with refrigerant and oil.
 5. Drains must be provided in the base of each condensing section to eliminate standing water.
- Z. Electrical:
 1. Wire units according to NEC and ETL list the entire unit. ETL listing of electrical panel only is unacceptable. All major electrical components shall be UL listed. Factory wire unit for single point power connection. Enclose all power wiring in liquid tight conduit.
 2. Provide fused disconnect, fan motor starters/protectors, contactors, control transformer, control circuit fusing, service switch, and terminal block. Units supplied with VFCs shall have individual branch fusing per drive. A motor protector shall be provided if equipment manufacturer's manual bypass is required.
 3. Provide NEMA 3R electrical/control panel.
 4. Factory test wiring and controls before shipment.
 5. A phase/voltage protection relay shall be provided for each unit. Upon sensing a loss of phase or voltage the unit shall be de-energized.

6. A door safety kill switch shall be provided on all blower section access doors. The door safety kill switch shall de-energize the blower motor if the access door is opened. The kill switch shall prevent motor startup if the blower section access door is open.
 7. Lights: Provide vapor proof marine lights in all access sections. Wire lights to a single light switch. Mount light switch near the electrical panel and wire switch to a terminal strip in the electrical panel. Separate 120V power must be provided to the switch. A transformer will be provided to provide power to the lighting circuit.
 8. Convenience Receptacles: Provide a GFCI duplex receptacle mounted near the electrical panel and wire receptacle to a terminal strip in the electrical panel. Separate 120V power must be provided to the receptacle. A transformer will be provided to provide power to the circuit.
 9. Dirty filter indicators: Provide differential pressure switches across all filter racks. Wire pressure switches to terminal block in main electrical panel.
- AA. Piping: Fabricate units with space within housing for piping.
- BB. DDC System:
1. Manufacturer must provide a stand-alone programmable digital control system for complete temperature & humidity control of the delivered air. The manufacturer will provide a standard sequence of operation for the type of equipment provided per this specification. The controller will be programmed to control room temperature and humidity. The sequence of operation will include the following:
 - a. Temperature control for all heating & cooling devices.
 - b. Humidity control for all cooling devices.
 - c. Humidity control using the OA & RA dampers.
 - d. Economizer control for free cooling.
 - e. Defrost control for all energy recovery devices.
 - f. Pressure control for exhaust fan.
 - g. The controller will communicate with the BAS through a Bacnet IP.
- CC. Special Construction and Coatings:
1. Interior casing exposed to the pool air shall be constructed of aluminum or steel with a baked corrosion resistant coating.
 2. Blowers shall be completely coated with Hi-Pro Polyester..
 3. Steel parts exposed to the pool air shall be coated with air-dried phenolic.
 4. Coils exposed to the pool air shall be coated with baked phenolic.
 5. Recirculation damper, exhaust damper, and backdraft damper must be constructed of aluminum.
 6. VFC must be provided for the exhaust fan to control space pressure.
- DD. Source Quality Control:

1. Verification of Performance: Factory test and rate dehumidification units according to ARI 910.
2. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to ARI 575.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is from exhaust side to purge section to supply side.
 1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
 2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
 3. Access doors and panels are specified in Division 23 Section "Duct Accessories."
 4. For outdoor units: Provide waterproof roof with standing seam construction and positive slope to ensure water drainage.
- B. Install heat-pipe heat exchangers so supply and exhaust airstreams flow in opposite directions. Install flexible connectors on ducts to enable tilt control; make connections airtight and with slack to compensate for full tilt.
 1. Install heat exchanger with clearance space for heat-pipe coil removal.
 2. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to both sides of heat-pipe coil. Access doors and panels are specified in Division 23 Section "Duct Accessories."
 3. Install tilt-control components, including electronic controller, electric actuator and linkage, thermostats, and sensors.
- C. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
 1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 23 Section "Duct Accessories."
- D. Install floor-mounted units on 4-inch- high concrete base.
- E. Support suspended units from structure; use threaded steel rods.
- F. Install units with clearances for service and maintenance.
- G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.
- H. Pipe condensate drains from heat exchanger units and drain pans to nearest floor drain or roof drain; use ASTM B 88, Type L, drawn-temper copper water tubing with soldered joints, same size

as condensate drain connection. Provide electrical heat trace for condensate drains for roof mounted equipment.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Units shall be provided complete for single point connection to hydronic piping system.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Duct and fan installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and specialties.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 4. Set initial temperature and humidity set points.
 - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.
- C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 20 Section "Mechanical General Requirements."

****END OF SECTION****

HEATING AND COOLING COILS

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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.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 23 Sections for coils that are integral to air-handling units.

1.2 SUMMARY

- A. This Section includes duct-mounted heating and cooling coils, and heating and cooling coils that are an integral part of air-handling units.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each coil. Include rated capacity and pressure drop for each coil.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.
4. JCI/York International.
5. Luvata/Heatcraft Commercial/Industrial Products.
6. Precision Coils; a business of Unison Comfort Technologies.
7. Trane Inc.; a Division of Ingersoll Rand.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.024 inch wall thickness, and minimum 0.50 inch diameter.

F. Fins: Aluminum, minimum 0.010 inch thick.

G. Headers: Cast iron with cleaning plugs, and drain and air vent tappings or seamless copper tube with brazed joints, prime coated.

H. Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.0625 inch thick for flanged mounting.

I. Frames, Chilled Water Coils: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.

J. Coating: Heresite P-403 baked phenolic for coils installed in stainless steel ductwork.

2.2 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
2. Carrier; a United Technologies Company.
3. Daikin Applied; a member of Daikin Industries, Ltd.

4. JCI/York International.
 5. Luvata/Heatcraft Commercial/Industrial Products.
 6. Precision Coils; a business of Unison Comfort Technologies.
 7. Trane Inc.; a Division of Ingersoll Rand.
- B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
 - C. Minimum Working-Pressure Rating: 300 psig.
 - D. Source Quality Control: Factory tested to 450 psig.
 - E. Tubes: ASTM B 743 copper, minimum 0.020 inch wall thickness, and minimum 0.50 inch diameter.
 - F. Fins: Aluminum, minimum 0.010 inch thick.
 - G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.
 - H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch thick for flanged mounting.
- 2.3 DRAIN PANS
- A. Description: For cooling coils, IAQ compliant formed to slope from all directions to the drain connection as required by ASHRAE 62.
 - B. Construction: Minimum 22 gage, Type 304 stainless steel with welded joints, positively sloped a minimum of 1/8 inch per foot, with threaded drain connection at lowest point of pan. Intermediate pans piped to the primary drain pan are required for all stacked cooling coils.
 - C. Provide intermediate coils with 3 inch deep pans for each tiered coil bank. Top pan shall extend 6 inches beyond face of coil and bottom pan shall extend not less than 12 inches beyond face of coil. Where more than two panes are used, pan extension shall be proportional.
 - D. Supports: Same material as pans.
 - E. Pipe pan drain to floor drain. A deep seal trap shall be installed on the drain pipe from the pans.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

- C. Laboratory Terminal Unit Hot Water Coils: Caulk and seal frame and all housing tube openings in the field with a non-hardening sealant. Sealant type shall be approved by the coil manufacturer.
- D. Install minimum 22 gage, Type 304 stainless-steel drain pan under each cooling coil.
 - 1. Construct drain pans with connection for drain; insulated.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- E. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- F. Straighten bent fins on air coils.
- G. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Hydronic Piping."
- D. Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section "Temperature Controls," and other piping specialties are specified in Division 23 Section "Steam and Condensate Piping."
- E. Connect refrigerant piping according to Division 23 Section "Refrigerant Piping."
- F. Ground equipment according to Division 26 Section "Grounding and Bonding."
- G. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

****END OF SECTION****

ELECTRICAL GENERAL REQUIREMENTS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES

- A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. American National Standards Institute
2. A.S.T.M. American Society for Testing Materials
3. I.C.E.A. Insulated Cable Engineers Association
4. I.E.E.E. Institute of Electrical and Electronics Engineers
5. N.E.C. National Electrical Code
6. N.E.C.A National Electrical Contractors Association
7. N.E.M.A. National Electrical Manufacturer's Association
8. U.L. Underwriters Laboratories, Inc.
9. N.E.C.A. 1-2000, "Practices for Good Workmanship in Electrical Contracting (ANSI)."

1.4 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
 1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.
- C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

1.5 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.

- B. Rules of local utility companies shall be complied with. Coordinate with the utility company supplying service to the installation and determine all devices including, but not limited to, all current and potential transformers, meter boxes, C.T. cabinets and meters which will be required and include the cost of all such items and all utilities costs in proposal.
- C. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

- A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.
- C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

- A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer's latest design.
- B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

1.8 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

- A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.
 - 1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.
 - 2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.
- B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

- A. Submit project-specific submittals for review in compliance with Division 1.
- B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.
- C. Provide detailed layout shop Drawings (on transparent media) of all lighting and power distribution systems, routing of conduits, combining of circuits, circuiting, details and related information necessary of installation and maintenance. After review by the Architect/Engineer, a copy of Drawings will be stamped and returned to the Contractor.
- D. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.
- E. Submit for approval shop drawings for all electrical systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures). Refer to other sections of the electrical Specifications for additional requirements. Unit substations.

1.11 COORDINATION DRAWINGS

- A. Submit project specified coordination drawings for review in compliance with Division 1 Specification Sections.

1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

- A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.
- B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.
- C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:
 - 1. Routine maintenance procedures.
 - 2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
 - 3. Trouble-shooting procedures.
 - 4. Contractor's telephone numbers for warranty repair service.
 - 5. Submittals.
 - 6. Recommended spare parts lists.
 - 7. Names and telephone numbers of major material suppliers and subcontractors.
 - 8. System schematic drawings on 8-1/2" x 11" sheets.

1.13 RECORD DRAWINGS

- A. Submit record drawings in compliance with Division 1.
- B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or mylar which have been neatly marked to represent as-built conditions for all new electrical work.
- C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.14 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.

- B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.
- D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.

1.15 WARRANTY

- A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner's satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
- B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.16 USE OF EQUIPMENT

- A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.
- B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

- A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.
- B. Device Location:
 - 1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

3.2 DEMOLITION WORK

- A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.

- B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.
- C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.
- D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.
- E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or at the panels.
- F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.
- G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.
- H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, relamped and reconditioned suitable for satisfactory operation and appearance.

3.3 TEMPORARY SERVICES

- A. Provide and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, a complete temporary electrical and telephone service during construction.

3.4 CHASES AND RECESSES

- A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.5 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

- A. Refer to General Conditions for requirements.
- B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.

3.6 EXCAVATION AND BACKFILLING

- A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.

- B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.
- C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
- D. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.7 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.8 CLEANING

- A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.
- B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be protected from theft, injury or damage.
- B. Protect conduit openings with temporary plugs or caps.
- C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.10 EXTRA WORK

- A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done.

Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 1/2", 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, I.G. receptacle, data box, fire alarm horn/strobe, fire alarm strobe, P.A. speaker, clock, or other devices which may be required for any proposed extra work.

3.11 DRAWINGS AND MEASUREMENTS

- A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if call for by both. The Contractor understands that the work herein described shall be complete in every detail.
- B. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

****END OF SECTION****

SECONDARY UNIT SUBSTATIONS

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes indoor secondary unit substations, each consisting of the following:
 - 1. Primary incoming section (Existing primary switch to remain for re-use).
 - 2. Transformer.
 - 3. Secondary distribution section.
- B. Related Sections include the following:

1. Division 26 Section "Overcurrent Protective Device Coordination" for short-circuit rating of devices and for setting of overcurrent protective devices.
2. Division 26 Section "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.
3. Division 26 Section "Electrical Power Monitoring and Control" for communication features of power distribution system devices.
4. Division 26 Section "Surge Protective Devices" for surge protectors for low-voltage power, control, and communication equipment that may be located in secondary section.
5. Division 26 Section "Medium-Voltage Switchgear" for metering and instrument transformers.

1.3 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories: Include dimensions, manufacturer's anchorage and base recommendations.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
 2. Dimensioned plans and elevations showing major components and features.
 3. One-line diagram.
 4. List of materials.
 5. Nameplate legends.
 6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
 7. Short-time and short-circuit current ratings of secondary unit substations and components.
 8. Ratings of individual protective devices.
- C. Primary Fuses: Submit recommendations and size calculations.
- D. 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:
1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
 2. Location of structural supports for structure-supported raceways.
- E. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- F. Product Certificates: For secondary unit substations, signed by product manufacturer.
 - G. Qualification Data: For testing agency.
 - H. Factory test reports.
 - I. Field quality-control test reports.
 - J. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- D. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C2.
- F. Comply with IEEE C37.121.
- G. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

- B. Coordinate delivery of secondary unit substations to allow movement into designated space.
- C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.
- B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
- C. Service Conditions: IEEE C37.121, usual service conditions.

1.8 COORDINATION

- A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare fuses: Six of each type and rating of fuse used, except for medium-voltage fuses. Include spares for the following:
 - a. Potential transformer fuses.
 - b. Control power fuses.
 - c. Fuses and fusible devices for fused circuit breakers.
 - d. Fuses for secondary fusible devices.
 - 2. Touchup Paint: Two half-pint containers of paint matching enclosure's exterior finish.
 - 3. Primary Switch Contact Lubricant: One container.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Square D; Schneider Electric. (Basis of Design)
 2. Eaton; Cutler Hammer. (must field verify existing room dimensions for code clearances of new substations)
 3. Siemens. (must field verify existing room dimensions for code clearances of new substations)

2.2 MANUFACTURED UNITS

- A. Indoor Unit Arrangement: Single assembly.
- B. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

- A. Primary Incoming Section: Existing primary switch to remain for re-use.
- B. Primary Incoming Section: Enclosed, air-interrupter, primary switch. Existing primary switch to remain. Field verify requirements for new transformer section to match-up with existing primary switch. Manufacturer shall field coordinate requirements for Kirk Key Interlocks.
1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, without fuses, complying with IEEE C37.20.3.
 2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
 3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
 4. Window: Permits viewing switch-blade positions when door is closed.
 5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
 6. Continuous-Current Rating: 600 A.
 7. Short-Circuit Rating:
 - a. Short-time momentary asymmetrical fault rating of 40 kA.
 - b. 3-second symmetrical rating of 25-kA RMS.
 - c. Fault close asymmetrical rating of 40 kA.
- C. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

- D. Insulators: Shall be porcelain or cyclo-aliphatic insulators.

2.4 DRY-TYPE TRANSFORMER SECTION

- A. Description: IEEE C57.12.01, IEEE C57.12.50, IEEE C57.12.51 NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.
- B. Enclosure: Indoor, ventilated, vacuum-pressure, impregnated type and with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- C. Cooling System: Class AA, air cooled complying with IEEE C57.12.01.
- D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.
- E. Insulation Temperature Rise: **80** deg C, maximum rise above 40 deg C.
- F. Basic Impulse Level: 95 kV.
- G. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
- H. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

2.5 SECONDARY DISTRIBUTION SECTION – LOW VOLTAGE SWITCHBOARD

A. MANUFACTURED UNITS

1. Front-Connected, Front-Accessible Switchboard: Individually-mounted drawout main device, panel-mounted branches, and sections rear aligned.
2. Nominal System Voltage: As noted on Drawings.
3. Main-Bus Continuous: As noted on Drawings.
4. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
5. Enclosure: Steel, NEMA 250, Type 1 not over 102 in height.
6. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
7. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.
8. Insulation and isolation for main and vertical buses of feeder sections.
9. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
10. Bolted Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
11. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - a. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - 1) Use copper for feeder circuit-breaker line connections.

- b. Ground Bus: 1/4-by-2-inch minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 - c. Contact Surfaces of Buses: Silver plated.
 - d. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - e. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - f. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
12. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

B. SURGE SUPPRESSIVE DEVICES

1. IEEE C62.41, panel mounted, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules.
2. Minimum single-impulse current rating shall be as follows:
 - a. Line to Neutral: 100,000 A.
 - b. Line to Ground: 100,000 A.
 - c. Neutral to Ground: 50,000 A.
3. Protection modes shall be as follows:
 - a. Line to neutral.
 - b. Line to ground.
 - c. Neutral to ground.
4. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
5. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.
6. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 480Y/277 V systems.
7. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
8. Accessories:
 - a. Audible alarm activated on failure of any surge diversion module.
 - b. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

C. OVERCURRENT PROTECTIVE DEVICES

1. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
 - a. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - b. Main breaker shall have electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

- 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long- and short-time time adjustments.
 - 4) Ground-fault pickup level, time delay, and I^2t response.
- c. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- d. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
2. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
- a. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - b. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

D. INSTRUMENTATION

1. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:
 - a. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
 - b. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.
2. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
 - a. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - 1) Phase Currents, Each Phase: Plus or minus 1 percent.
 - 2) Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - 3) Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - 4) Megawatts: Plus or minus 2 percent.
 - 5) Megavars: Plus or minus 2 percent.
 - 6) Power Factor: Plus or minus 2 percent.
 - 7) Frequency: Plus or minus 0.5 percent.
 - 8) Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - 9) Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 - b. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

E. ACCESSORY COMPONENTS AND FEATURES

1. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

2. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.6 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
 1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
 2. Ratios on the rated voltage connection and on tap extreme connections.
 3. Polarity and phase relation on the rated voltage connection.
 4. No-load loss at rated voltage on the rated voltage connection.
 5. Exciting current at rated voltage on the rated voltage connection.
 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.

PART 3 - EXECUTION

3.1 MANUFACTURER SHALL COORDINATE AND PROVIDE SERVICES LISTED BELOW TO THE ELECTRICAL CONTRACTOR THAT WILL BE ASSIGNED TO HANDLE AND INSTALL THE SECONDARY UNIT SUBSTATIONS.

3.2 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 1. Wiring entries comply with layout requirements.
 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.
- D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install and anchor secondary unit substations on concrete bases, according to manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 "Hangers and Supports for Electrical Systems."
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.4 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs.
- B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.5 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.6 CLEANING

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing."
 - 1. Perform each visual and mechanical inspection and electrical test for each component of substation according to NETA ATS, including secondary injection testing. Certify compliance with test parameters.
 - a. Verify all trip functions by means of primary/secondary injection, as required.
 - 2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
 - 3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
 - 4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

- a. Remove and replace malfunctioning units and retest as specified above.

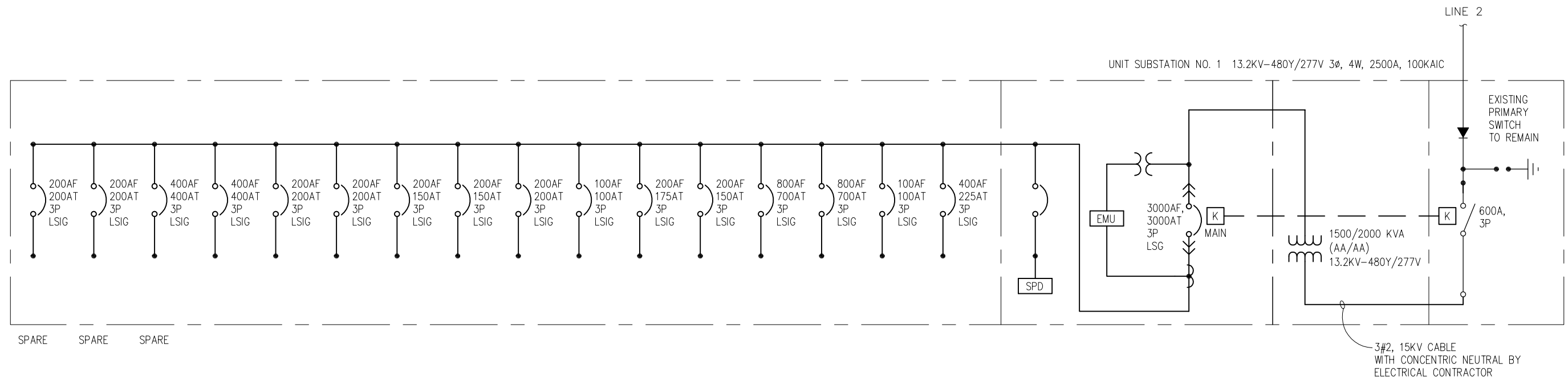
3.8 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters calibrated to an accuracy of 1% of the nominal voltage measured. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
 - a. Adjust transformer taps.
 - b. Rebalance loads.
 - c. Prepare written request for voltage adjustment by electric utility.
 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
 4. Report: Prepare a written report covering monitoring performed and corrective action taken.

3.9 DEMONSTRATION

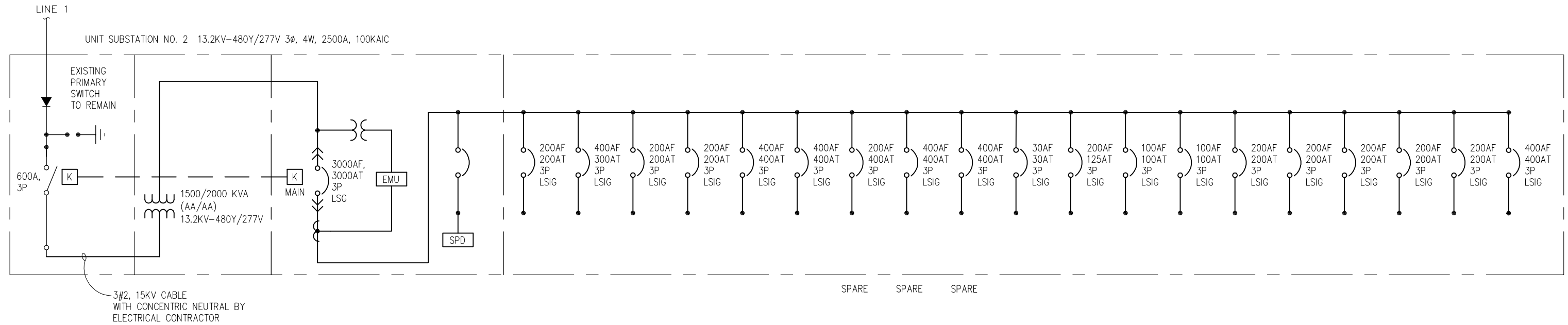
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 1 Section "Demonstration and Training."

****END OF SECTION****



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PROJECT NO. PBA 2013-0407 PAGE E-1 DATE 1-27-15
 PROJECT ATHENS HS BP #8A PRE-PURCHASE PACKAGE
 SUBJECT SUBSTATION NO. 1 BY JRD



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PROJECT NO. PBA 2013-0407 PAGE E-2 DATE 1-27-15
 PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE
 SUBJECT SUBSTATION NO. 2 BY JRD

MODULAR AIR HANDLING UNIT COMPONENT SCHEDULE

UNIT IDENTIFICATION	LOCATION	AREA SERVED	POSITION NUMBER 1	POSITION NUMBER 2	POSITION NUMBER 3	POSITION NUMBER 4	POSITION NUMBER 5	POSITION NUMBER 6	MAXIMUM UNIT LENGTH	EXISTING UNIT REPLACED	MODEL/REMARKS
AHU-1	MECHANICAL C308	SOUTH AUDITORIUM	MIXING BOX	AF-1	HC-1	12" ACCESS	CC-1	SF-1	130	LCAC-1	CAH035GDAC / DCV
AHU-2	MECHANICAL C308	NORTH AUDITORIUM	MIXING BOX	AF-2	HC-2	12" ACCESS	CC-2	SF-2	130	LCAC-2	CAH035GDAC / DCV
AHU-3	MECHANICAL C308	2ND FL. ENGLISH	MIXING BOX	AF-3	HC-3	12" ACCESS	CC-3	SF-3	144	LCAC-3	CAH040GDAC
AHU-4	MECHANICAL C308	1ST FL. SOUTH CAFE & GUIDANCE	MIXING BOX	AF-4	HC-4	12" ACCESS	CC-4	SF-4	108	LCAC-4	CAH013GDAM
AHU-5	MECHANICAL C308	1ST FL. BUSINESS LABS	MIXING BOX	AF-5	HC-5	12" ACCESS	CC-5	SF-5	106	LCAC-5	CAH017GDAM
AHU-6	MECHANICAL C308	2ND FL. MEDIAL LANGUAGES	MIXING BOX	AF-6	HC-6	12" ACCESS	CC-6	SF-6	102	LCAC-6	CAH025GDAM
AHU-7	MECHANICAL C308	1ST FL. KITCHEN, CAFE, TEACHER CAFE, PREP CAFE	MIXING BOX	AF-7	HC-7	12" ACCESS	CC-7	SF-7	110	LCAC-7	CAH015GDAM
AHU-8	MECHANICAL C308	1ST FL. CAFETERIA	MIXING BOX	AF-8	HC-8	12" ACCESS	CC-8	SF-8	106	LCAC-8	CAH016GDAM
AHU-9	MECHANICAL C308	2ND FL. SOCIAL SCIENCES	MIXING BOX	AF-9	HC-9	12" ACCESS	CC-9	SF-9	122	LCAC-9	CAH032GDAM
AHU-10	MECHANICAL F300	1ST FL. HOME SCIENCES (MATH)	MIXING BOX	AF-10	HC-10	12" ACCESS	CC-10	SF-10	108	LCAC-10	CAH011GDAM
AHU-11	MECHANICAL F300	1ST FL. PRE-SCHOOL AND 2ND FL. SCIENCE J200	MIXING BOX	AF-11	HC-11	12" ACCESS	CC-11	SF-11	102	LCAC-11	CAH014GDAM
AHU-12	MECHANICAL G211	WEST GYM	MIXING BOX	AF-12	HC-12	12" ACCESS	CC-12	SF-12	132	LCAC-12	CAH041GDAM / ELEVATED, DCV
AHU-13	MECHANICAL G211	EAST GYM	MIXING BOX	AF-13	HC-13	12" ACCESS	CC-13	SF-13	132	LCAC-13	CAH041GDAM / ELEVATED, DCV
AHU-15	MECHANICAL D221	1ST FLOOR MATHEMATICS	MIXING BOX	AF-15	HC-15	12" ACCESS	CC-15	SF-15	90	LCAC-15	CAH017GDAC
AHU-16	MECHANICAL D221	2ND FLOOR BIOLOGY	MIXING BOX	AF-16	HC-16	12" ACCESS	CC-16	SF-16	94	LCAC-16	CAH021GDAC / VAV
AHU-17	MECHANICAL D221	2ND FLOOR CHEMISTRY	MIXING BOX	AF-17	HC-17	12" ACCESS	CC-17	SF-17	86	LCAC-17	CAH010GDAC
AHU-18	MECHANICAL A135	1ST FLOOR MAIN OFFICE	MIXING BOX	AF-18	HC-18	12" ACCESS	CC-18	SF-18	76	LCAC-18	CAH008GDAM / DX
AHU-19	UPPER J115/J116	VEJ138/1341	MIXING BOX	AF-19	HC-19	12" ACCESS	CC-19	SF-19	100	LCAC-19	MODEL CAH010GDAC / SUSPENDED, VAV
AHU-21	MECHANICAL B201	BAND B113, VOCAL B124	MIXING BOX	AF-21	HC-21	12" ACCESS	CC-21	SF-21	118	LCAC-21	CAH028GDAM / VAV
AHU-22	MECHANICAL B200	ART	MIXING BOX	AF-22	HC-22	12" ACCESS	CC-22	SF-22	108	LCAC-22	CAH013GDAM
AHU-23	MECHANICAL B201	DRESSING B144/1635	MIXING BOX	AF-23	HC-23	12" ACCESS	CC-23	SF-23	86	LCAC-23	CAH003GDAM
AHU-24	MECHANICAL B200	LOWER LEVEL REHEARSAL	MIXING BOX	AF-24	HC-24	12" ACCESS	CC-24	SF-24	86	LCAC-24	CAH003GDAC
AHU-25	MECHANICAL G300	GYM BALCONY G202	MIXING BOX	AF-25	HC-25	12" ACCESS	CC-25	SF-25	116	LCAC-25	CAH028GDBM / DCV
AHU-26	MECHANICAL F300	GYM BALCONY G216	MIXING BOX	AF-26	HC-26	12" ACCESS	CC-26	SF-26	112	LCAC-26	CAH018GDBM / SUSPENDED, DCV
AHU-27	MECHANICAL F300	FOOD STORAGE E110, E128	MIXING BOX	AF-27	HC-27	12" ACCESS	CC-27	SF-27	82	LCAC-27	CAH003GDAC / SUSPENDED
AHU-28	MECHANICAL F300	POOL BALCONY	MIXING BOX	AF-28	HC-28	12" ACCESS	CC-28	SF-28	60	LCUV-5	CAH003GDAC / DX, NO HEAT

NOTE:

1. MODULES SELECTED BASED ON DAIKIN INDOOR AIR HANDLING UNIT.
2. POSITION NUMBERS ARE INDICATED IN THE DIRECTION OF AIRFLOW FROM RETURN AIR INLET TO SUPPLY AIR DISCHARGE.
3. PROVIDE ALL UNITS LOCATED ON THE FLOOR WITH 12" BASE AND ALL SUSPENDED UNITS WITH 4" BASE.



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PROJECT NO. PBA 2013-0407

PAGE M-1

DATE 1-27-15

PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE

SUBJECT MODULAR AHU COMPONENT SCHEDULE

BY GRN

HEATING AND VENTILATING UNIT COMPONENT SCHEDULE

UNIT IDENTIFICATION	LOCATION	AREA SERVED	POSITION NUMBER 1	POSITION NUMBER 2	POSITION NUMBER 3	POSITION NUMBER 4	MAXIMUM UNIT LENGTH	EXISTING UNIT REPLACED	MODEL NUMBER	REMARKS
HVU-1	MEZZANINE G300	GYM - BOYS LOCKER ROOM	MIXING BOX	AF-1HV	HC-1HV	SF-1HV	94	LCUV-1	MODEL CAH012GHAM	100%OA W/RECIRC
HVU-2	MEZZANINE F300	GYM - GIRLS LOCKER ROOM	MIXING BOX	AF-2HV	HC-2HV	SF-2HV	82	LCUV-2	MODEL CAH009GHAM	100%OA W/RECIRC VERTICAL INSTALLATION
HVU-3	MEZZANINE F300	POOL - LOCKER ROOM	MIXING BOX	AF-3HV	HC-3HV	SF-3HV	84	LCUV-3	MODEL CAH007GHAM	100%OA W/RECIRC VERTICAL INSTALLATION
HVU-6	CONDITIONING ROOM F212	CONDITIONING ROOM F212	MIXING BOX	AF-6HV	HC-6HV	SF-6HV	68	LCUV-6	MODEL CAH004GHAC	SUSPENDED FROM STRUCTURE
HVU-7	MEZZANINE F300	KITCHEN MAKE-UP AIR	AF-7HV	HC-7HV	SF-7HV	--	68	LCUV-7	MODEL CAH008GHAC	100%OA
HVU-8	MEZZANINE F300	KITCHEN & TERRACE MAKE-UP AIR	AF-8HV	HC-8HV	SF-8HV	--	64	LCUV-8	MODEL CAH007GHAM	100%OA
HVU-9	MEZZANINE F300	KITCHEN & TERRACE MAKE-UP AIR	AF-9HV	HC-9HV	SF-9HV	--	64	LCUV-9	MODEL CAH006GHAM	100%OA
HVU-10	V.E. J136/1335	V.E. J136/1335	MIXING BOX	AF-10HV	HC-10HV	SF-10HV	74	LCUV-10	MODEL CAH004GHAC	SUSPENDED FROM STRUCTURE
HVU-13	MECHANICAL LAB J143/1321	MECHANICAL LAB J143/1321	MIXING BOX	AF-13HV	HC-13HV	SF-13HV	72	LCUV-13	MODEL CAH004GHAC	SUSPENDED FROM STRUCTURE
HVU-14	DRAFTING LAB J139/1320	DRAFTING LAB J139/1320	MIXING BOX	AF-14HV	HC-14HV	SF-14HV	76	LCUV-14	MODEL CAH006GHAC	SUSPENDED FROM STRUCTURE
HVU-15	LAB J129/1333	LAB J129/1333	MIXING BOX	AF-15HV	HC-15HV	SF-15HV	72	LCUV-15	MODEL CAH004GHAC	SUSPENDED FROM STRUCTURE
HVU-16	MEZZANINE F300	LAUNDRY F132/ELEV EQUIPM.	MIXING BOX	AF-16HV	HC-16HV	SF-16HV	70	LCUV-16	MODEL CAH006GHAM	100% OA, SUSPENDED FROM STRUCTURE

NOTE:

1. MODULES SELECTED BASED ON DAIKIN INDOOR AIR HANDLING UNIT.
2. POSITION NUMBERS ARE INDICATED IN THE DIRECTION OF AIRFLOW FROM RETURN AIR INLET TO SUPPLY AIR DISCHARGE.
3. PROVIDE ALL UNITS LOCATED ON THE FLOOR WITH 12" BASE AND ALL SUSPENDED UNITS WITH 4" BASE.



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PROJECT NO. PBA 2013-0407 PAGE M-2 DATE 1-27-15

PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE

SUBJECT HVU COMPONENT SCHEDULE BY GRN

AIR HANDLING UNIT FILTER SCHEDULE

UNIT I.D.	SYSTEM SERVED	TYPE	AIRFLOW CFM	AIR PRESS. DROP		EFFICIENCIES		FILTER MEDIA					HOUSING				MODEL NO.	REMARKS
				INITIAL IN. W.G.	DIRTY IN. W.G.	MERV	D.S. %	QUAN.	WIDTH IN.	HEIGHT IN.	DEPTH IN.	MIN. MEDIA FACE AREA SQ. FT.	ACCESS TYPE	WIDTH IN.	HEIGHT IN.	DEPTH IN.		
AF-1	AHU-1	PLEATED	15460	0.16	1.0	13	65	15	20	20	4	39.1	SIDE	102	66	8	-	
AF-2	AHU-2	PLEATED	15460	0.16	1.0	13	65	15	20	20	4	39.1	SIDE	102	66	8	-	
AF-3	AHU-3	PLEATED	19620	0.19	1.0	13	65	9 6	24 20	20 20	4 4	43.9	SIDE	116	68	8	-	
AF-4	AHU-4	PLEATED	6050	0.22	1.0	13	65	2 1 2	24 20 24	20 20 12	4 4 4	12.6	SIDE	72	40	8	-	
AF-5	AHU-5	PLEATED	7520	0.19	1.0	13	65	2 2 3	24 20 24	20 20 12	4 4 4	17.0	SIDE	90	40	8	-	
AF-6	AHU-6	PLEATED	11675	0.19	1.0	13	65	3 1 3 1	24 20 24 20	24 24 20 20	4 4 4 4	26.6	SIDE	94	52	8	-	
AF-7	AHU-7	PLEATED	6900	0.17	1.0	13	65	2 4	24 20	20 20	4 4	16.7	SIDE	68	46	8	-	
AF-8	AHU-8	PLEATED	7050	0.18	1.0	13	65	1 3 3	24 20 24	20 20 12	4 4 4	16.5	SIDE	86	40	8	-	
AF-9	AHU-9	PLEATED	13750	0.18	1.0	13	65	6 2 2	24 20 12	24 24 24	4 4 4	32.7	SIDE	108	56	8	-	
AF-10	AHU-10	PLEATED	5280	0.20	1.0	13	65	3 2	20 24	20 12	4 4	11.5	SIDE	64	40	8	-	
AF-11	AHU-11	PLEATED	5500	0.17	1.0	13	65	3 1	24 12	24 24	4 4	13.2	SIDE	86	36	8	-	
AF-12	AHU-12	PLEATED	18250	0.18	1.0	13	65	10 2 4	20 12 24	24 24 12	4 4 4	42.5	SIDE	112	68	8	-	
AF-13	AHU-13	PLEATED	18250	0.18	1.0	13	65	10 2 4	20 12 24	24 24 12	4 4 4	42.5	SIDE	112	68	8	-	
AF-15	AHU-15	PLEATED	7950	0.18	1.0	13	65	6	24	20	4	18.9	SIDE	80	46	8	-	
AF-16	AHU-16	PLEATED	9360	0.17	1.0	13	65	4 4	20 20	24 20	4 4	23.0	SIDE	82	52	8	-	
AF-17	AHU-17	PLEATED	5100	0.26	1.0	13	65	3	20	24	4	9.4	SIDE	64	36	8	-	
AF-18	AHU-18	PLEATED	3675	0.30	1.0	13	65	2 1	20 12	24 24	4 4	8.1	SIDE	54	34	8	-	
AF-19	AHU-19	PLEATED	4500	0.21	1.0	13	65	3	20	24	4	9.4	SIDE	64	36	8	-	
AF-21	AHU-21	PLEATED	8800	0.10	1.0	13	65	1 4 1 4	24 20 24 20	24 24 20 20	4 4 4 4	29.9	SIDE	108	50	8	-	
AF-22	AHU-22	PLEATED	6000	0.21	1.0	13	65	2 1 2	24 20 24	20 20 12	4 4 4	12.6	SIDE	70	40	8	-	
AF-23	AHU-23	PLEATED	1000	0.12	1.0	13	65	1	24	20	4	3.1	SIDE	38	26	8	-	
AF-24	AHU-24	PLEATED	1600	0.36	1.0	13	65	1	24	20	4	3.1	SIDE	38	26	8	-	
AF-25	AHU-25	PLEATED	12960	0.19	1.0	13	65	6 4	24 20	20 20	4 4	29.3	SIDE	114	48	8	-	
AF-26	AHU-26	PLEATED	8640	0.25	1.0	13	65	3 1 1	24 20 12	24 24 24	4 4 4	16.4	SIDE	108	36	8	-	
AF-27	AHU-27	PLEATED	1200	0.15	1.0	13	65	1	24	20	4	3.1	SIDE	38	26	8	-	
AF-28	AHU-28	PLEATED	1500	0.21	1.0	13	65	1	24	20	4	3.1	SIDE	38	26	8	-	
AF-1HV	HVU-1	PLEATED	5450	0.20	1.0	13	65	1 2 2	24 20 24	20 20 12	4 4 4	12.1	SIDE	68	40	8	-	
AF-2HV	HVU-2	PLEATED	2700	0.10	1.0	13	65	1 1 1	24 20 12	24 24 24	4 4 4	8.8	SIDE	60	36	8	-	
AF-3HV	HVU-3	PLEATED	3600	0.30	1.0	13	65	2	20	24	4	6.3	SIDE	46	36	8	-	
AF-6HV	HVU-6	PLEATED	1500	0.20	1.0	13	65	1	24	20	4	3.1	SIDE	38	26	8	-	
AF-7HV	HVU-7	PLEATED	4200	0.20	1.0	13	65	1 1 1	24 20 12	24 24 24	4 4 4	8.8	SIDE	58	34	8	-	
AF-8HV	HVU-8	PLEATED	3150	0.20	1.0	13	65	1	24	24	4	6.9	SIDE	50	34	8	-	
AF-9HV	HVU-9	PLEATED	2450	0.10	1.0	13	65	2 1	20 12	24 24	4 4	8.1	SIDE	54	30	8	-	
AF-10HV	HVU-10	PLEATED	2750	0.30	1.0	13	65	1	24	24	4	5.6	SIDE	40	30	8	-	
AF-13HV	HVU-13	PLEATED	2000	0.10	1.0	13	65	1	24	24	4	5.6	SIDE	40	30	8	-	
AF-14HV	HVU-14	PLEATED	3600	0.20	1.0	13	65	2	24	24	4	7.6	SIDE	52	30	8	-	
AF-15HV	HVU-15	PLEATED	2750	0.20	1.0	13	65	1 1	24 12	24 24	4 4	5.6	SIDE	40	30	8	-	
AF-16HV	HVU-16	PLEATED	2000	0.10	1.0	13	65	2 1	20 12	24 24	4 4	5.6	SIDE	40	30	8	-	

NOTE:
 1. MODEL NUMBERS ARE FARR UNLESS OTHERWISE NOTED.
 2. PROVIDE 25% TO 30% EFFICIENT 2 INCH THROW AWAY PREFILTERS
 3. MERV DESIGNATES THE "MINIMUM EFFICIENCY REPORTING VALUE" AS EVALUATED UNDER ASHRAE STANDARD 52.2 1999.
 4. AIR HANDLING UNIT TOTAL STATIC PRESSURE FOR VARIABLE AIR VOLUME SYSTEMS IS BASED ON THE FILTER DIRTY AIR PRESSURE DROP AND AVERAGE/MIDLIFE FILTER AIR PRESSURE DROP FOR CONSTANT VOLUME SYSTEMS UNLESS NOTED OTHERWISE.



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PROJECT NO. PBA 2013-0407

PAGE M-3

DATE 1-27-15

PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE

SUBJECT AHU/HVU FILTER SCHEDULE

BY GRN

HOT WATER HEATING COIL SCHEDULE

UNIT IDENTIFICATION	SYSTEM SERVED	MAXIMUM NUMBER ROWS	MAXIMUM FIN DENSITY FINS/INCH	CAPACITY MBH	AIR				MINIMUM FACE AREA SQ. FT.	WATER				MODEL NUMBER	REMARKS
					AIRFLOW CFM	E.D.B. °F	L.D.B. °F	MAXIMUM A.P.D. IN. W.G.		FLOW GPM	E.W.T. °F	L.W.T. °F	MAXIMUM W.P.D. FT. HEAD		
HC-1	AHU-1	2	13	455	15460	54	81	0.12	32.25	29.2	150	119	4.20	5WQ1301B	
HC-2	AHU-2	2	13	455	15460	54	81	0.12	32.25	29.2	150	119	4.20	5WQ1301B	
HC-3	AHU-3	1	6	182	19620	54	62	0.12	29.17	11.5	150	118	0.90	5WB0601B	
HC-4	AHU-4	1	6	170	6050	54	80	0.11	9.33	11.3	150	120	0.20	5WB0601B	
HC-5	AHU-5	1	6	70	7520	54	62	0.10	12.33	4.5	150	119	0.30	5WB0601B	
HC-6	AHU-6	1	6	105	11675	54	62	0.11	17.88	7.0	150	120	0.40	5WB0601B	
HC-7	AHU-7	1	6	52	6900	54	61	0.13	9.75	3.5	150	120	0.10	5WB0601B	
HC-8	AHU-8	1	6	65	7050	54	62	0.10	11.67	4.2	150	120	0.20	5WB0601B	
HC-9	AHU-9	1	6	137	13750	54	63	0.10	23.00	9.0	150	119	0.70	5WB0601B	
HC-10	AHU-10	1	6	43	5280	54	61	0.11	8.00	3.0	150	121	0.10	5WB0601B	
HC-11	AHU-11	1	6	53	5500	54	63	0.08	10.21	3.5	150	119	0.20	5WB0601B	
HC-12	AHU-12	2	11	920	18250	54	100.0	0.34	36.00	61.2	150	120	5.80	5WH1102C	
HC-13	AHU-13	2	11	920	18250	54	100.0	0.34	36.00	61.2	150	120	5.80	5WH1102C	
HC-15	AHU-15	1	6	67	7950	54	61	0.11	12.00	4.5	150	120	0.20	5WB0601B	
HC-16	AHU-16	1	6	83	9360	54	62	0.10	15.13	5.5	150	120	0.10	5WB0601B	
HC-17	AHU-17	1	6	36	5100	54	60	0.14	7.00	2.5	150	121	0.10	5WB0601B	
HC-18	AHU-18	1	6	28	3675	54	61	0.08	6.33	2.0	150	121	0.1	5WB0601B	
HC-19	AHU-19	2	13	182	4500	54	91	0.35	7.00	12.0	150	120	0.80	5WH1302B	
HC-21	AHU-21	1	6	105	8800	54	64	0.10	19.17	7.0	150	120	0.50	5WB0601B	
HC-22	AHU-22	3	10	310	6000	54	100	0.42	9.50	20.0	150	119	2.90	5WH1102C	
HC-23	AHU-23	2	9	28	1000	54	80.3	0.20	1.83	2.0	150	121	0.10	5WH0902B	
HC-24	AHU-24	2	10	45	1600	54	80	0.25	2.75	3.0	150	120	0.10	5WH1002B	
HC-25	AHU-25	2	14	640	12960	54	100	0.37	24.50	43.0	150	120	7.5	5WH1102C	
HC-26	AHU-26	2	11	430	8640	54	100	0.33	17.25	29.0	150	120	5.10	5WH1102C	
HC-27	AHU-27	1	11	21	1200	54	70.0	0.17	1.83	1.5	150	121	0.17	5WQ1101B	
HC-1HV	HVU-1	3	11	590	5450	-10.0	89.1	0.67	9.17	40.0	150	120	11.1	5WH1103C	
HC-2HV	HVU-2	3	11	291	2700	-10.0	88.7	0.21	6.85	20.0	150	120	3.0	5WH1103B	
HC-3HV	HVU-3	4	11	399	3600	-10.0	91.5	0.53	6.19	26.0	150	119	3.8	5WH1104B	
HC-6HV	HVU-6	3	8	67	1500	50.0	91.1	0.26	2.88	4.3	150	119	0.2	5WH0803B	
HC-7HV	HVU-7	3	11	455	4200	-10.0	89.1	0.61	7.50	30.0	150	119	6.0	5WH1103C	
HC-8HV	HVU-8	3	11	345	3150	-10.0	90.0	0.52	6.17	22.7	150	119	3.3	5WH1103C	
HC-9HV	HVU-9	3	9	265	2450	-10.0	87.8	0.31	5.98	17.3	150	120	2.6	5WH0903C	
HC-10HV	HVU-10	3	8	115	2750	50.0	88.3	0.43	3.94	7.5	150	119	0.4	5WH0803B	
HC-13HV	HVU-13	3	10	120	2000	50.0	104.5	0.48	3.94	7.8	150	119	0.5	5WH1003C	
HC-14HV	HVU-14	2	13	142	3600	50.0	86.1	0.39	5.25	9.3	150	120	0.4	5WH1302B	
HC-15HV	HVU-15	2	13	91	2750	50.0	80.3	0.49	3.50	6.0	150	120	0.2	5WH1302B	
HC-16HV	HVU-16	3	10	180	2000	-10	73.0	0.37	3.42	12.0	150	120	2.6	5WH1003B	

NOTE:
 1. MODEL NUMBERS ARE DAIKIN UNLESS OTHERWISE NOTED.
 2. COIL SELECTION BASED ON .00025 FOULING FACTOR.


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PROJECT NO. PBA 2013-0407 PAGE M-4 DATE 1-27-15
 PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE
 SUBJECT HOT WATER HEATING SCHEDULE BY GRN

CHILLED WATER COOLING COIL SCHEDULE

UNIT IDENTIFICATION	SYSTEM SERVED	MINIMUM NUMBER ROWS	TOTAL CAPACITY MBH	AIR						MINIMUM FACE AREA SQ. FT.	WATER				MODEL NUMBER	REMARKS
				AIRFLOW CFM	E.D.B. °F	E.W.B. °F	L.D.B. °F	L.W.B. °F	MAXIMUM A.P.D. IN. W.G.		FLOW GPM	E.W.T. °F	L.W.T. °F	MAXIMUM W.P.D. FT. HEAD		
CC-1	AHU-1	(2) 6	520	15460	78.0	65.0	54.4	53.8	0.67	33.38	118.0	45	54.2	8.4	5WM1106B	
CC-2	AHU-2	(2) 6	520	15460	78.0	65.0	54.4	53.8	0.67	33.38	118.0	45	54.2	8.4	5WM1106B	
CC-3	AHU-3	(2) 8	695	19620	78.0	65.0	53.7	53.1	0.84	38.63	144.0	45	55.7	16.9	5WM0808B	
CC-4	AHU-4	8	236	6050	78.0	65.0	51.9	51.7	0.98	12.29	50.4	45	54.9	14.30	5WS1108B	
CC-5	AHU-5	8	285	7520	78.0	65.0	52.5	52.2	0.97	16.04	58.4	45	55.2	8.10	5WM1208B	
CC-6	AHU-6	8	476	11675	80.0	67.0	54.0	53.7	0.91	23.63	97.5	45	55.2	13.4	5WM0908B	
CC-7	AHU-7	8	252	6900	78.0	65.0	53.0	52.7	0.95	13.75	52.2	45	55.1	10.6	5WM1008B	
CC-8	AHU-8	8	275	7050	78.0	65.0	51.8	51.6	0.84	15.21	56.8	45	55.2	20.6	5WS1008B	
CC-9	AHU-9	6	494	13750	80.0	67.0	56.2	55.5	0.70	27.71	101.2	45	55.2	12.9	5WM1006B	
CC-10	AHU-10	8	195	5,280	78.0	65.0	52.9	52.5	0.87	10.63	39.6	45	55.3	17.7	5WL0908B	
CC-11	AHU-11	6	194	5,500	78.0	65.0	53.6	53.1	0.54	13.69	40.6	45	55.0	10.3	5WS1106B	
CC-12	AHU-12	(2) 8	672	18,250	78.0	65.0	53.0	52.6	0.86	37.13	137.7	45	55.2	15.1	5WM0908B	
CC-13	AHU-13	(2) 8	672	18,250	78.0	65.0	53.0	52.6	0.86	37.13	137.7	45	55.2	15.1	5WM0908B	
CC-15	AHU-15	8	295	7,950	78.0	65.0	52.8	52.4	0.81	16.75	60.1	45	55.3	15.5	5WS0908B	
CC-16	AHU-16	8	340	9,360	78.0	65.0	53.3	52.8	0.73	20.13	70.9	45	55.0	16.8	5WS0808B	
CC-17	AHU-17	8	186	5,100	78.0	65.0	53.0	52.7	1.12	9.56	38.6	45	55.1	9.8	5WS1108B	
CC-18	AHU-18	--	133	3,675	78.0	65.0	54.4	52.8	0.94	6.83	--	--	--	--	5EJ1006B	DX COIL
CC-19	AHU-19	8	168	4,500	78.0	65.0	52.7	52.4	0.8	9.56	34.0	45	55.3	16.0	5WL0908B	
CC-21	AHU-21	8	326	8,800	78.0	65.0	52.8	52.5	0.73	19.79	66.8	45	55.2	11.9	5WM0908B	
CC-22	AHU-22	8	220	6,000	78.0	65.0	52.9	52.6	0.96	11.80	45.5	45	55.1	11.8	5WS1008B	
CC-23	AHU-23	8	36	1,000	78.0	65.0	52.8	52.6	0.44	3.13	7.5	45	55.2	4.4	5WH0908B	
CC-24	AHU-24	8	57	1,600	78.0	65.0	53.3	53.0	0.98	3.13	11.9	45	55.0	9.9	5WH1008B	
CC-25	AHU-25	8	475	12,960	78.0	65.0	53.0	52.7	0.92	25.25	97.0	45	55.2	18.7	5WM0908B	
CC-26	AHU-26	8	310	8,640	78.0	65.0	53.1	52.7	0.84	17.19	64.7	45	55.2	13.2	5WM0908B	
CC-27	AHU-27	6	35	1,200	78.0	65.0	56.0	55.4	0.43	3.13	7.3	45	55.1	3.2	5WH1006B	
CC-28	AHU-28	4	60	1,500	84.0	69.0	58.8	56.5	0.59	3.13	-	-	-	-	5EN1204B	

NOTE:

1. MODEL NUMBERS ARE DAIKIN UNLESS OTHERWISE NOTED.
2. COIL SELECTIONS BASED ON .00025 FOULING FACTOR.



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PROJECT NO. PBA 2013-0407

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DATE 1-27-15

PROJECT ATHENS HS BP#8A PRE-PURCHASE PACKAGE

SUBJECT CHILLED WATER COOLING COIL SCHEDULE BY GRN

AIR HANDLING UNIT SUPPLY AIR FAN SCHEDULE

UNIT IDENTIFICATION	SYSTEM SERVED	TYPE	AIRFLOW CFM	MINIMUM OUTSIDE AIR FLOW CFM	E.S.P. IN. W.G.	T.S.P. IN. W.G.	MINIMUM WHEEL DIAMETER INCHES	RPM	OUTLET VELOCITY FPM	FAN CLASS	MOTOR				MODULATION/CONTROL TYPE	ELECTRICAL			MAXIMUM SOUND POWER LEVELS																		REMARKS							
											BHP	HP	RPM	DRIVE TYPE		VOLTS	PHASE	OPTIONS/ACCESSORIES	UNIT DISCHARGE Lw BY OCTAVE BAND						UNIT INLET Lw BY OCTAVE BAND						CASING RADIATED Lw BY OCTAVE BAND													
																			63 HZ (DB)	125 HZ (DB)	250 HZ (DB)	500 HZ (DB)	1000 HZ (DB)	2000 HZ (DB)	4000 HZ (DB)	8000 HZ (DB)	63 HZ (DB)	125 HZ (DB)	250 HZ (DB)	500 HZ (DB)	1000 HZ (DB)	2000 HZ (DB)	4000 HZ (DB)	8000 HZ (DB)	63 HZ (DB)	125 HZ (DB)		250 HZ (DB)	500 HZ (DB)	1000 HZ (DB)	2000 HZ (DB)	4000 HZ (DB)	8000 HZ (DB)	
																			SF-1	AHU-1	CENTRIFUGAL	15460	3092	0.75	2.63	24	1665	2196	2	11.27	15.0	1750	BELT	AUTO	460	3		B	93	95	96	91	88	82
SF-2	AHU-2	CENTRIFUGAL	15460	3092	0.75	2.63	24	1665	2196	2	11.27	15.0	1750	BELT	AUTO	460	3	B	93	95	96	91	88	82	78	70	91	93	93	87	83	77	71	69	85	87	84	74	68	59	43	34		
SF-3	AHU-3	CENTRIFUGAL	19620	3920	1.15	3.21	27	1353	2575	1	14.74	20	1750	BELT	AUTO	460	3	B	92	94	95	90	87	81	77	69	89	91	91	86	80	74	67	68	84	86	83	73	67	58	72	33		
SF-4	AHU-4	CENTRIFUGAL	6050	1210	1.0	3.14	16.19	2485	1704	2	4.82	7.5	1750	BELT	AUTO	460	3	B	86	88	86	87	81	75	71	63	83	85	82	83	74	68	61	62	78	80	74	70	61	52	36	27		
SF-5	AHU-5	CENTRIFUGAL	7520	1500	1.0	3.18	16.19	2830	2118	2	6.90	7.5	1750	BELT	AUTO	460	3	B	90	92	90	91	85	79	75	67	87	89	86	87	78	72	65	66	82	84	78	74	65	56	40	31		
SF-6	AHU-6	CENTRIFUGAL	11675	2335	1.65	3.77	19.69	2245	2479	2	13.05	15	1750	BELT	AUTO	460	3	B	94	96	94	95	89	83	79	71	91	93	90	91	82	76	69	70	86	88	82	78	69	60	44	35		
SF-7	AHU-7	CENTRIFUGAL	6900	1380	1.0	3.18	16.19	2878	1944	2	5.97	7.5	1750	BELT	AUTO	460	3	B	88	90	88	89	83	77	73	65	85	87	84	85	76	70	63	64	80	82	76	72	63	54	38	29		
SF-8	AHU-8	CENTRIFUGAL	7050	1410	1.0	3.05	16.19	2700	1986	2	6.01	7.5	1750	BELT	AUTO	460	3	B	88	90	88	89	83	77	73	65	85	87	84	85	76	70	63	64	80	82	76	72	63	54	38	29		
SF-9	AHU-9	CENTRIFUGAL	13750	2750	1.2	3.10	20.00	2113	3251	2	12.21	15	1750	BELT	AUTO	460	3	B	95	97	98	93	90	84	80	72	93	95	95	89	85	79	73	71	87	89	86	76	70	61	45	36		
SF-10	AHU-10	CENTRIFUGAL	5280	1060	1.0	3.07	16.19	2307	1487	2	3.93	5	1750	BELT	AUTO	460	3	B	83	85	83	84	78	72	68	60	80	82	79	80	71	65	58	59	75	77	71	67	58	49	33	24		
SF-11	AHU-11	CENTRIFUGAL	5500	1360	1.0	2.68	13.22	3671	2582	2	6.02	7.5	1750	BELT	AUTO	460	3	B	93	95	93	91	91	82	78	70	91	93	90	87	86	77	71	69	85	87	81	74	71	59	43	34		
SF-12	AHU-12	CENTRIFUGAL	18250	3650	1.0	3.42	22.25	2023	3544	2	18.14	20	1750	BELT	AUTO	460	3	B	97	99	100	95	92	86	82	74	94	96	96	91	85	79	72	73	89	91	88	78	72	63	47	38		
SF-13	AHU-13	CENTRIFUGAL	18250	3650	1.0	3.42	22.25	2023	3544	2	18.14	20	1750	BELT	AUTO	460	3	B	97	99	100	95	92	86	82	74	94	96	96	91	85	79	72	73	89	91	88	78	72	63	47	38		
SF-15	AHU-15	CENTRIFUGAL	7950	1590	0.85	2.99	19.69	1805	1688	1	6.05	7.5	1750	BELT	AUTO	460	3	B	87	89	87	88	82	76	72	64	84	86	83	84	75	69	62	63	79	81	75	71	62	53	37	28		
SF-16	AHU-16	CENTRIFUGAL	9360	1872	1.5	3.55	19.69	2044	1987	2	8.77	10	1750	BELT	AUTO	460	3	B	89	91	89	90	84	78	74	66	86	88	85	86	77	71	64	65	81	83	77	73	64	55	39	30		
SF-17	AHU-17	CENTRIFUGAL	5100	1020	1.5	3.97	16.19	2349	1437	2	4.77	5.0	1750	BELT	AUTO	460	3	B	84	86	84	85	79	73	69	61	81	83	80	81	72	66	59	60	76	78	72	68	59	50	34	25		
SF-18	AHU-18	CENTRIFUGAL	3675	735	0.75	2.65	10.62	1760	3500	1	3.59	5.0	1750	BELT	AUTO	460	3	B	86	89	84	83	85	81	80	77	84	87	81	79	80	76	73	76	78	81	72	66	65	58	45	41		
SF-19	AHU-19	CENTRIFUGAL	4500	900	1.0	3.24	13.22	3297	2113	2	4.58	5.0	1750	BELT	VAV	460	3	B	88	90	88	89	83	77	73	65	85	87	84	85	76	70	63	64	80	82	76	72	63	54	38	29		
SF-21	AHU-21	CENTRIFUGAL	8800	1760	0.75	2.79	24.50	1445	0	2	5.45	7.5	1750	BELT	VAV	460	3	B	89	81	90	85	86	82	80	73	82	75	85	75	70	71	64	68	78	70	75	65	63	56	42	34		
SF-22	AHU-22	CENTRIFUGAL	6000	1200	1.0	3.47	14.56	3105	2083	2	6.38	7.5	1750	BELT	AUTO	460	3	B	91	93	91	92	86	80	76	68	88	90	87	88	79	73	66	67	83	85	79	75	66	57	41	32		
SF-23	AHU-23	CENTRIFUGAL	1000	200	0.5	2.11	9.5	1643	1724	2	0.66	1.0	1750	BELT	AUTO	460	3	B	71	71	68	67	69	66	65	62	68	68	64	63	62	59	55	61	63	63	56	50	49	43	30	26		
SF-24	AHU-24	CENTRIFUGAL	1600	320	0.5	2.84	9.5	2020	2759	2	1.62	2.0	1750	BELT	AUTO	460	3	B	81	81	78	77	77	78	75	72	78	78	74	73	70	71	65	71	73	73	66	60	57	55	40	36		
SF-25	AHU-25	CENTRIFUGAL	12960	2595	1.25	3.77	15.00	1342	2107	1	15.44	20.0	1750	BELT	AUTO	460	3	B	86	88	88	86	84	80	80	75	83	85	84	82	77	73	70	74	78	80	76	69	64	57	45	39		
SF-26	AHU-26	CENTRIFUGAL	8640	1730	1.15	3.41	12.62	1537	1982	1	9.18	10	1750	BELT	AUTO	460	3	B	87	92	87	84	89	85	80	79	84	89	83	80	82	78	70	78	79	84	75	67	69	62	45	43		
SF-27	AHU-27	CENTRIFUGAL	1200	240	1.3	3.01	9.5	1719	2069	2	1.08	1.5	1750	BELT	AUTO	460	3	B	75	75	72	71	73	70	69	66	73	73	69	67	68	65	62	65	67	67	60	54	53	47	34	30		
SF-28	AHU-28	CENTRIFUGAL	1500	---	0.75	2.56	9.5	1912	2586	2	1.36	1.5	1750	BELT	AUTO	460	3	B	80	80	77	76	78	75	74	71	79	79	76	75	77	74	73	70	72	72	65	59	58	52	39	35		
SF-1HV	HVU-1	CENTRIFUGAL	5450	5450	0.5	2.25	16.19	2306	1535	2	3.52	5.0	1750	BELT	AUTO	460	3	B	80	82	82	80	78	74	74	69	79	81	81	79	77	73	73	68	72	74	70	63	58	51	39	33		
SF-2HV	HVU-2	CENTRIFUGAL	2700	2700	0.5	1.79	10.62	1252	1837	1	1.64	2.0	1750	BELT	AUTO	460	3	B	79	82	77	76	78	74	73	70	78	81	76	75	77	73	72	69	71	74	65	59	58	51	38	34		
SF-3HV	HVU-3	CENTRIFUGAL	3600	3600	0.5	2.13	9.5	1252	1837	1	4.65	5.0	1750	BELT	AUTO	460	3	B	91	91	88	87	87	88	85	82	90	90	87	86	86	87	84	81	83	83	76	70	67	65	50	46		
SF-6HV	HVU-6	CENTRIFUGAL	1500	375	0.5	1.87	9.5	1898	2586	2	1.13	1.5	1750	BELT	AUTO	460	3	B	80	80	77	76	78	75	74	71	79	79	76	75	77	74	73	70	72	72	65	59	58	52	39	35		
SF-7HV	HVU-7	CENTRIFUGAL	4200	4200	0.5	2.11	13.22	3037	1972	2	3.13	5.0	1750	BELT	AUTO	460	3	B	87	89	87	88	82	76	72	64	84	86	84	85	79	73	69	61	79	81	75	71	62	53	37	28		
SF-8HV	HVU-8	CENTRIFUGAL	3150	3150	0.5	2.02	10.62	1655	3000	2	2.31	3.0	1750	BELT	AUTO	460	3	B	82	85	80	79	81	77	76	73	79	82	77	76	78	74	73	70	74	77	68	62	61	54	41	37		
SF-9HV	HVU-9	CENTRIFUGAL	2450	2450	0.5	1.81	10.62	1507	2333	1	1.41	2.0	1750	BELT	AUTO	460	3	B	77	80	75	74	76	72	71	68	74	77	72	71	73	69	68	65	69	72	63	57	56	49	36	32		
SF-10HV	HVU-10	CENTRIFUGAL	2750	690	0.5	2.02	9.5	1838	3571	2	2.67	3.0	1750	BELT	AUTO	460	3	B	88	88	85	84	86	83	82	79	87	87	84	83	85	82	81	78	80	80	73	67	66	60	47	43		
SF-13HV	HVU-13	CENTRIFUGAL	2000	500	0.5	2.04	9.5	1749	2597	1	1.44	2.0	1750	BELT	AUTO	460	3	B	79	79	76	75	77	74	73	70	78	78	75	74	76	73	72	69	7									

POOL DEHUMIDIFICATION UNIT SCHEDULE

UNIT I.D	SUPPLY AIR				EXHAUST AIR			HEAT EXCHANGER (SUMMER)						HEAT EXCHANGER (WINTER)						COOLING - DX				HEATING - NATURAL GAS				HOT GAS REHEAT COIL (HEAT RECLAIM)			AIR-COOLED CONDENSING SECTION						
	CFM	MIN OA SUMMER/WINTER	ESP"	TSP"	CFM SUMMER/WINTER	ESP"	TSP"	SUPPLY SIDE			EXHAUST SIDE			EFFIC. (%)	SUPPLY SIDE			EXHAUST SIDE			EFFIC. (%)	UNIT MOISTURE REMOVAL LB/HR	CFM	CAPACITY TOTAL/SENS. MBH	E.A.T. °F	L.A.T. °F	INPUT MBH	OUTPUT MBH	E.D.T. °F	L.D.T. °F	GAS PRESS. IN.	CAPACITY TOTAL MBH	E.D.T. °F	L.D.T. °F	DESIGN AMB. TEMP °F	MIN AMB. TEMP °F	NO. OF FANS
								E.A.T. °F	L.A.T. °F	A.P.D. IN. WG.	E.A.T. °F	L.A.T. °F	A.P.D. IN. WG.		E.A.T. °F	L.A.T. °F	APD IN. WC	E.A.T. °F	L.A.T. °F	APD IN. WC																	
DU-1	20000	10000/5000	1.5	5.08	12000/7000	1.0	2.88	90/73	86.1/71.8	0.73	82	85.1	1.0	50	-10	45.9	0.60	82	51.5	0.52	60	313	10000	478/299	86.1/71.8	58.5/57.8	600	480	73.1	95.3	7-14	278	70.3	83.1	95	45	4

NOTE:
 1. REFER TO SCHEDULES GENERAL NOTES.
 2. MODEL NUMBERS ARE INNOVENT UNLESS OTHERWISE NOTED.
 3. COORDINATE UNIT CONFIGURATION WITH PLANS IN ORDER TO ALLOW FOR PROPER SERVICE ACCESS.
 4. PROVIDE SINGLE POINT ELECTRICAL CONNECTION WITH MAIN DISCONNECT.

POOL DEHUMIDIFICATION UNIT SCHEDULE

UNIT I.D	HEATING - NATURAL GAS						HOT GAS REHEAT COIL (HEAT RECLAIM)			AIR-COOLED CONDENSING SECTION				OA FILTERS			RETURN FILTERS			ELECTRICAL						UNIT WEIGHT (LBS)	UNIT LOCATION	SA/RA CONFIG.	EA/OA CONFIG	MODEL NO.	REMARKS	
	L.A.T. °F	INPUT MBH	OUTPUT MBH	E.D.T. °F	L.D.T. °F	GAS PRESS. IN.	CAPACITY TOTAL MBH	E.D.T. °F	L.D.T. °F	DESIGN AMB. TEMP °F	MIN AMB. TEMP °F	NO. OF FANS	NO. OF COMPR.	EFF. %	AREA SQ. FT.	SP" TOTAL	EFF. %	AREA SQ. FT.	SP" TOTAL	SUPPLY FAN BHP/HP	EXHAUST FAN BHP/HP	VOLTS	PHASE	MCA	MOP							OPTIONS/ACCESSORIES
DU-1	58.5/57.8	600	480	73.1	95.3	7-14	278	70.3	83.1	95	45	4	2	30	16.7	1.0	30	16.7	1.0	11.03/2x15	7.57/10	460	3	131.2	150	B, C	16,500	OUTDOOR	HORIZ./HORIZ.	HORIZ./HORIZ.	ERU-OU-PL-20000-DX-HG-IF-FF-AC-460	SEE NOTE

