DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 0501 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Furnish labor, materials, and equipment necessary for completion of work as described in Contract Documents.

B. It is the intent of these specifications that the systems specified herein are to be complete and operational before being turned over to the owner. During the bidding process, the contractor is to ask questions or call to the engineer's attention any items that are not shown or may be required to make the system complete and operational. Once the project is bid and the contractor has accepted the contract, it is his responsibility to furnish and install all equipment and parts necessary to provide a complete and operational system without additional cost to the owner.

C. Furnish and install fire stopping materials to seal penetrations through fire rated structures and draft stops.

D. Includes But Not Limited To:
1. General procedures and requirements for HVAC.

E. Related Sections:
1. Section 23 0593: Testing, Adjusting, and Balancing for HVAC.

1.3 SUBMITTALS

A. Substitutions: By specific designation and description, standards are established for specialties and equipment. Other makes of specialties and equipment of equal quality will be considered provided such proposed substitutions are submitted to the Architect for his approval, complete with specification data showing how it meets the specifications, at least 5 working days prior to bid opening. A list of approved substitutions will be published as an addendum.
1. Submit a single copy of Manufacturer's catalog data including Manufacturer's complete specification for each proposed substitution.
2. The Architect or Engineer is to be the sole judge as to the quality of any material offered as an equal.

B. Product Data, Shop Drawings: Within 30 days after award of contract, submit Manufacturer's catalog data for each manufactured item.
1. Literature shall include enough information to show complete compliance with Contract Document requirements.
2. Mark literature to indicate specific item with applicable data underlined.
3. Information shall include but not be limited to capacities, ratings, type of material used, guarantee, and such dimensions as are necessary to check space requirements.
4. When accepted, submittal shall be an addition to Contract Documents and shall be in equal force. No variation shall be permitted.
5. Even though the submittals have been accepted by the Engineer, it does not relieve the contractor from meeting all of the requirements of the plans and specifications and providing a complete and operational system.

C. Drawings of Record: One complete sets of blue line mechanical drawings shall be provided for the

purpose of showing a complete picture of the work as actually installed.

1. These drawings shall serve as work progress report sheets. Contractor shall make notations neat and legible therein daily as the work proceeds.
2. The drawings shall be kept at the job at a location designated by the Mechanical Engineer.
3. At completion of the project these "as-built" drawings shall be signed by the Contractor, dated, and returned to the Architect.

D. Operating Instructions and Service Manual: The Mechanical Contractor shall prepare 2 copies of an Operation and Maintenance Manual for all mechanical systems and equipment used in this project. Manuals shall be bound in hard-backed binders and the front cover and spine of each binder shall indicate the name and location of the project. Use plastic tab indexes for all sections. Provide a section for each different type of equipment item. The following items shall be included in the manual, together with any other pertinent data. This list is not complete and is to be used as a guide.

1. Provide a master index at the beginning of the manual showing all items included.
2. The first section of the manual shall contain:
   a. Names, addresses, and telephone numbers of Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor, and Temperature Control Contractor.
   b. List of Suppliers which shall include a complete list of each piece of equipment used with the name, address, and telephone number of vendor.
   c. General Description of Systems including –
      1) Location of all major equipment
      2) Description of the various mechanical systems
      3) Description of operation and control of the mechanical systems
      4) Suggested maintenance schedule
   d. Copy of contractor's written warranty
3. Provide a copy of approved submittal literature for each piece of equipment.
4. Provide maintenance and operation literature published by the manufacturer for each piece of equipment which includes: oiling, lubrication and greasing data; belt sizes, types and lengths; wiring diagrams; step-by-step procedure to follow in putting each piece of mechanical equipment in operation.
5. Include parts numbers of all replaceable items.
6. Provide control diagram and operation sequence, along with labeling of control piping and instruments to match diagram.
7. Include a valve chart indicating valve locations.

E. Include air balance and/or water balance reports.

1.4 SUBMITTALS FOR COMMON HVAC REQUIREMENTS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:

1. Manufacturer’s installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
2. Specification data on sealer and gauze proposed for sealing ductwork.

C. Quality Assurance

1. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
2. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Perform work in accordance with applicable provisions of local and state Plumbing Code, Gas Ordinances, and adoptions thereof. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
2. In case of differences between building codes, state laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Architect in writing of such differences.

B. Applicable Specifications: Referenced specifications, standards, and publications shall be of the issues in effect on date of Advertisement for Bid.
1. "Heating, Ventilating and Air Conditioning Guide" published by the American Society of Heating and Air Conditioning Engineers.
2. "Engineering Standards" published by the Heating, Piping, and Air Conditioning Contractors National Association.
3. "2018 International Building Code", "2018 International Mechanical Code", “2018 International Plumbing Code” and "2018 International Fire Code" as published by the International Conference of Building Officials.
4. "National Electrical Code" as published by the National Fire Protection Association.
5. "2018 International Energy Conservation Code ".

C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

1.6 INSPECTIONS AND PERMITS

A. Pay for permits, fees, or charges for inspection or other services. Local and state codes and ordinances must be properly executed without expense to Owner and are considered as minimum requirements. Local and state codes and ordinances do not relieve the Contractor from work shown that exceeds minimum requirements.

1.7 ADDITIONAL WORK:

A. Design is based on equipment as described in the drawing equipment schedule. Any change in foundation bases, electrical wiring, conduit connections, piping, controls and openings required by alternate equipment submitted and approved shall be paid for by this division. All work shall be in accordance with the requirements of the applicable sections.

PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

A. Finishes, Where Applicable: Colors as selected by Architect.

B. Duct Hangers:
1. One inch 25 mm by 18 ga 1.27 mm galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches 2 400 mm apart. Do not use wire hangers.
2. Attaching screws at trusses shall be 2 inch 50 mm No. 10 round head wood screws. Nails not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Inspection:
1. Examine premises and understand the conditions which may affect performance of work of this Division before submitting proposals for this work.
2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.

B. Drawings:
   1. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc, and do not attempt to show complete details of building construction which affect installation. This Contractor shall refer to architectural, structural, and electrical drawings for additional building detail which affect installation of his work.
      a. Follow mechanical drawings as closely as actual building construction and work of other trades will permit.
      b. No extra payments will be allowed where piping and/or ductwork must be offset to avoid other work or where minor changes are necessary to facilitate installation.
      c. Everything shown on the mechanical drawings shall be the responsibility of Mechanical Contractor unless specifically noted otherwise.
   2. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.
   3. Because of small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions. Do not scale drawings for locations of equipment or piping. Refer to large scale dimensioned drawings for exact locations.

C. Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
   1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
   2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

3.2 PREPARATION

A. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
   1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
   2. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
   3. Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

3.3 INSTALLATION

A. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.

3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and assume complete responsibility for losses due to any cause whatsoever. Storage shall not interfere with traffic conditions in any public thoroughfare.

B. Protect completed work, work underway, and materials against loss or damage.

C. Close pipe openings with caps or plugs during installation. Cover fixtures and equipment and protect against dirt, or injury caused by water, chemical, or mechanical accident.

3.5 EXCAVATION AND BACKFILL

A. Perform necessary excavation of whatever substance encountered for proper laying of all pipes and underground ducts.
   1. Excavated materials not required for fill shall be removed from site as directed by Engineer.
   2. Excavation shall be carried low enough to allow a minimum coverage over underground piping of 5'-0" or to be below local frost level.
   3. Excess excavation below required level shall be backfilled at Contractor's expense with earth, sand, or gravel as directed by Engineer. Tamp ground thoroughly.
   4. Ground adjacent to all excavations shall be graded to prevent water running into excavated areas.

B. Backfill pipe trenches and allow for settlement.
   1. Backfill shall be mechanically compacted to same density as surrounding undisturbed earth.
   2. Cinders shall not be used in backfilling where steel or iron pipe is used.
   3. No backfilling shall be done until installation has been approved by the Engineer.

3.6 COOPERATION

A. Cooperate with other crafts in coordination of work. Promptly respond when notified that construction is ready for installation of work under Division 23000. Contractor will be held responsible for any delays which might be caused by his negligence or failure to cooperate with the other Contractors or crafts.

3.7 SUPERVISION

A. Provide a competent superintendent in charge of the work at all times. Anyone found incompetent shall be removed at once and replaced by someone satisfactory, when requested by the Architect.

3.8 INSTALLATION CHECK:

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule shall visit the project to inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the project as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying the following:
   1. Equipment has been properly installed and lubricated.
   2. Equipment is in accurate alignment.
   3. Equipment is free from any undue stress imposed by connecting piping or anchor bolts.
   4. Equipment has been operated under full load conditions.
   5. Equipment operated satisfactorily.

C. All costs for this installation check shall be included in the prices quoted by equipment suppliers.

3.9 CLEANING EQUIPMENT AND PREMISES

A. Properly lubricate equipment before Owner's acceptance.

B. Clean exposed piping, ductwork, equipment, and fixtures. Repair damaged finishes and leave everything in working order.

C. Remove stickers from fixtures and adjust flush valves.

D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.

E. Trap elements shall be removed during cleaning and flushing period. Replace trap elements and adjust after cleaning and flushing period.

3.10 TESTS

A. No piping work, fixtures, or equipment shall be concealed or covered until they have been inspected and approved by the inspector. Notify inspector when the work is ready for inspection.

B. All work shall be completely installed, tested as required by Contract Documents and the city and county ordinances and shall be leak-tight before the inspection is requested.

C. Tests shall be repeated to the satisfaction of those making the inspections.

D. Water piping shall be flushed out, tested at 100 psi and left under pressure of supply main or a minimum of 40 psi for the balance of the construction period.

3.11 WARRANTEE

A. Contractor shall guarantee work under Division 23 to be free from inherent defects for a period of one year from acceptance.
   1. Contractor shall repair, revise or replace any and all such leaks, failure or inoperativeness due to defective work, materials, or parts free of charge for a period of one year from final acceptance, provided such defect is not due to carelessness in operation or maintenance.
   2. In addition, the Contractor shall furnish all refrigeration emergency repairs, emergency service and all refrigerant required due to defective workmanship, materials, or parts for a period of one year from final acceptance at no cost to the Owner, provided such repairs, service and refrigerant are not caused by lack of proper operation and maintenance.

B. In addition to warrantee specified in General Conditions, heating, cooling, and plumbing systems are to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

3.12 SYSTEM START-UP, OWNER'S INSTRUCTIONS

A. Off-Season Start-up
   1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
   2. Notify Owner 7 days minimum before scheduled start-up.
   3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
   4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.

B. Owner's Instructions
   1. Instruct building maintenance personnel and Owner Representative in operation and maintenance of mechanical systems utilizing Operation & Maintenance Manual when so doing.
   2. Minimum instruction periods shall be as follows –
      a. Mechanical - Four hours.
      b. Temperature Control - Four hours.
      c. Refrigeration - Two hours.
   3. Instruction periods shall occur after Substantial Completion inspection when systems are properly working and before final payment is made.
   4. None of these instructional periods shall overlap another.

3.13 PROTECTION

A. Do not run heat pump, air handling units, fan coil units, or other pieces of equipment used for moving supply air without proper air filters installed properly in system.

B. The mechanical systems are not designed to be used for temporary construction heat. If any equipment is to be started prior to testing and substantial completion, such equipment will be returned to new condition with full one year warranties, from date of substantial completion after any construction use. This includes, but is not necessarily limited to: Equipment, filters, ductwork, fixtures, etc.

3.14 COMMON HVAC REQUIREMENTS:

A. INSTALLATION
1. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
2. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
3. Hangers And Supports:
   a. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
   b. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
   c. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
   d. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
   e. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

B. CLEANING
1. Clean interior of duct systems before final completion.

END OF SECTION 23 0501

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install identification of equipment and piping as described in Contract Documents.

B. Mechanical Contractor shall touch-up equipment where factory paint has been damaged. Repaint entire item where more than 20 percent of the surface is involved.

C. Primary painting of walls, ceilings, ductwork, piping and plenums is covered in the general painting section of these Contract Documents.

PART 2 - PRODUCTS

2.1 PAINT

A. Benjamin Moore Impervo or equivalent by Paint Manufacturer approved in Section 09 900.

B. Use appropriate primer.

2.2 LABELS

A. Black Formica with white reveal on engraving.

2.3 CODED BANDS

A. Using colored bands and arrows to indicate supply and return, with colored reflective tape, color code all piping installed in this contract at not more than 20-foot intervals, at equipment, at walls, etc., in accordance with ANSI Standards.

B. Approved Manufacturers:
   1. Seton
   2. Craftmark

2.4 PIPE IDENTIFICATION

A. In addition to the colored bands, stencil with black paint in 1/2 inch high letters a symbol and directional arrow for all fluids handled or use Seaton coded and colored pipe markers and arrows to meet ANSI Standards.

2.5 EQUIPMENT IDENTIFICATION

A. Provide an engraved plastic plate for each piece of equipment stating the name of the item, symbol number, area served, and capacity. Label all control components with plastic embossed mechanically attached labels. Sample:
   1. Supply Fan SF-1 - North Classrooms
   2. 10,000 CFM @ 2.5"

2.6 VALVE IDENTIFICATION

A. Make a list of and tag all valves installed in this work.
   1. Valve tags shall be of brass, not less than 1"x2" size, hung with brass chains.
   2. Tag shall indicate plumbing or heating service.

PART 3 - EXECUTION

3.1 APPLICATION

A. Engraved Plates:
   1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws –
      a. Equipment mark noted on Drawings (i.e., SF-1)
      b. Area served (i.e., North Classrooms)
      c. Capacity (10,000 CFM @ 2.5)

B. Stenciling:
   1. Locate identifying legends and directional arrows at following points on each piping system –
      a. Adjacent to each item of equipment and special fitting.
      b. At point of entry and exit where piping goes through wall.
      c. On each riser and junction.
      d. Every 50 feet on long continuous lines.
   2. Steam Pipe, Hot Water Heating, Chilled Water, Gas, & Valve Identification –
      a. Identify specific pipe contents by stenciling pipe with written legend and placing of arrows to indicate direction of flow.

C. Painting:
   1. Background Color - Provide by continuous painting of piping.

Symbol	Name	Color
NG	Natural Gas	Yellow
FS	Fire Sprinkler	Red

   2. Identification stenciling and flow arrows shall be following colors for proper contrast:

Arrows & ID Stenciling	Color Shade of Pipe
White	Red, Grays, & black
Black	Yellows, Oranges, Greens, & White

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 23 0501 - Common HVAC Requirements and Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY SCOPE

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems.
      a. Fan Coil Units.
      b. Exhaust Fans.
      c. DOAS Units.
      d. Dehumidifier Units.

1.3 SUBMITTALS

A. Agency Data:
   1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may not be the installing firm.

B. Engineer and Technicians Data:
   1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
   1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
   2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.
   3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
      a. General Information and Summary
      b. Air Systems

c. Temperature Control System Verification.

F. Report Contents: Provide the following minimum information, forms, and data:
1. General information and Summary: Inside cover sheet to identify testing, adjusting, balancing agency, Contractor, Owner, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the instrument calibration sheet.
2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting, and balancing work:
   a. All nameplate and specification data for all air handling equipment and motors.
   b. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
   c. Actual metered voltage at air handling equipment (phase-to-phase for all phases).
   d. Fan RPM for each piece of air handling equipment.
   e. Total actual CFM being handled by each piece of air handling equipment.
   f. Actual CFM of systems by rooms.
3. Certify that all smoke and fire dampers operate properly and can be reset under actual system operating conditions.

G. Calibration Reports:
1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.4 CERTIFICATION

A. Agency Qualifications:
1. Employ the services of a certified testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results, and operation of all systems to demonstrate satisfactory performance to the owner.
2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one person certified by NEBB or AABC as a Test and Balance supervisor, and a registered professional mechanical engineer, licensed in the state where the work will be performed.

B. Codes and Standard:
1. NEBB: “Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.”
2. AABC: “National Standards for Total System Balance.”
3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

1.5 PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operation and clean prior to beginning procedures.

1.6 SEQUENCING AND SCHEDULING

A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems within +10% to -5% of contract requirements.

B. The report shall be approved by the Engineer. Test and balance shall be performed prior to substantial completion.

PART 2 - NOT USED
PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps.
1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.
4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
5. Check filters for cleanliness and to determine if they are the type specified.
6. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning, and at proper operating setpoint.
7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
8. Determine best locations in main and branch ductwork for most accurate duct traverses.
9. Place outlet dampers in the full open position.
10. Prepare schematic diagrams of system "As-Built" ductwork and piping layouts to facilitate reporting.
11. Lubricate all motors and bearings.
12. Check fan belt tension.
13. Check fan rotation.

3.5 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all readings with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

3.6 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices, and the fan/motor drives within each system.

B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation, ductwork, and housings, using materials identical to those removed.

D. Seal ducts and piping, and test for and repair leaks.

E. Seal insulation to re-establish integrity of the vapor barrier.

F. Adjust timing relays of environmental equipment motor reduced voltage starters to the optimum time period for the motor to come up to the maximum reduced voltage speed and then transition to the full voltage speed to prevent damage to motor, and to limit starting current spike to the lowest possible and practical.

G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.7 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

C. Report shall be certified and stamped by a registered professional mechanical engineer employed by the agency and licensed in the state where the work will be performed.

D. Engineer is to provide a floor plan and test and balance contractor to include the plan in test and balance report and identify actual cfm on drawing or number the diffusers to match report.

3.8 DEMONSTRATION

A. If requested, testing, adjusting, and balancing agency shall conduct any or all of the field tests in the presence of the engineer.

B. Agency shall include a maximum of one (1) call back to the project within the one year warranty period to make additional adjustments if requested by the engineer.

END OF SECTION 23 0593

SECTION 23 0712 - MECHANICAL INSULATION AND FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install mechanical insulation and fire stopping as described in Contract Documents including but not limited to the following:
   1. Ductwork Insulation
   2. Refrigerant Piping
   3. Fire Stopping

1.3 QUALITY ASSURANCE

A. Insulation shall have composite (insulation, jacket or facing and adhesive used to adhere facing or jacket to insulation) fire and smoke hazard ratings as tested by Procedure ASTM E-84, NFPA 255 and UL 723 not exceeding: Flame Spread of 25 and Smoke Developed of 50.

B. Insulation Contractor shall certify in writing, prior to installation, that all products to be used will meet the above criteria.

C. Accessories, such as adhesives, mastics, cements, and tapes, for fittings shall have the same component ratings as listed above.

D. Products, or their shipping cartons, shall bear a label indicating that flame and smoke ratings do not exceed above requirements.

E. Any treatment of jacket or facings to impart flame and smoke safety shall be permanent.

F. The use of water-soluble treatments is prohibited.

END OF SECTION 23 0712

SECTION 23 0716 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on air ducts outside building insulation envelope as described in Contract Documents.

B. Furnish and install insulation on fresh air ducts and combustion air ducts within building insulation envelope as described in Contract Documents.

C. Furnish and install insulation on other air ducts where indicated on Drawings.

PART 2 - PRODUCTS

2.1 INSULATION

A. 1-1/2 inch thick fiberglass with aluminum foil scrim kraft facing and have a density of one lb/cu ft.

B. Approved Manufacturers:
1. Manville Microlite FSK
2. CSG Type IV standard duct insulation
3. Owens-Corning FRK
4. Knauf (Duct Wrap FSK)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct wrap in accordance with Manufacturer's recommendations.

B. Do not compress insulation except in areas of structural interference.

C. Completely seal joints.

END OF SECTION 23 0716

SECTION 23 0717 – ROUND SUPPLY DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install round supply duct insulation as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Insulation shall be UL rated with FSK (foil-skrim-kraft) facing.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fiberglass blanket insulation

B. Approved Manufacturers:
1. Johns-Manville R-4 Microlite (R-4 does not include the vapor barrier material).
2. Owens-Corning faced duct wrap insulation FRK-25 ED-150
3. Certainteed Standard Duct Wrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insulate round air supply ducts.

B. Facing shall overlap 2" at joints and shall be secured with outward clinch staples on 4" centers.

C. Ducts over 30" in width shall have spot application of adhesive, weld pins or metal screws and caps on not more than 18" centers applied to underside.

D. 3" wide vapor barrier paper shall be applied over seams and sealed with vapor barrier adhesive.

E. Insulate attenuators.

F. Insulate high and low pressure flex ducts.

END OF SECTION 23 0717

SECTION 23 0718 - DUCT LINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install acoustic lining in following above ground metal ductwork as described in Contract Documents unless detailed otherwise:
   1. Outside air
   2. Supply air
   3. Return air
   4. Mixed air
   5. Transfer air
   6. Relief air
   7. Elbows, fittings, and diffuser drops greater than 12 inches in length.

1.3 SYSTEM DESCRIPTION

A. Duct dimensions shown on Drawings are for free area inside insulation. Allowance must be made for insulation, where applicable.

1.4 RATINGS:

A. Material shall have maximum air friction correction factor of 1.10 at 1000 FPM velocity and have a minimum sound absorption coefficient NRC of .60.

PART 2 - PRODUCTS

2.1 DUCT LINER

A. One inch thick, 1-1/2 lb density fiberglass, factory edge coated.

B. Duct lining materials are to meet the requirements of UL 181 for mold, humidity, and erosion resistance.

C. Approved Manufacturers:
   1. Certainteed Ultralite 150 Certa Edge Coat
   2. Knauf - Type M
   3. Manville - Lina-Coustic
   4. Owen Corning Fiberglas - Aeroflex

2.2 ADHESIVE

A. Water Base Type:
   1. Cain - Hydrotak
   2. Duro Dyne - WSA
   3. Kingco - 10-568
   4. Miracle - PF-101
   5. Mon-Eco - 22-67
   6. Techno Adhesive - 133

B. Solvent Base (non-flammable) Type:
1. Cain - Safetak
2. Duro Dyne - FPG
3. Kingco - 15-137
4. Miracle - PF-91
5. Mon-Eco - 22-24
6. Techno Adhesive - 'Non-Flam' 106

C. Solvent Base (flammable) Type:
1. Cain - HV200
2. Duro Dyne - MPG
3. Kingco - 15-146
4. Miracle - PF-96
5. Mon-Eco - 22-22
6. Techno Adhesive - 'Flammable' 106

2.3 FASTENERS

A. Adhesively secured fasteners not allowed.

B. Approved Manufacturers:
1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
2. Cain
3. Duro Dyne
4. Omark dished head "Insul-Pins"
5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4 inch long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.

B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one piece, folded corners shall be tight against metal. Ends shall butt tightly together.

C. In casings and plenums further contain insulation with wire mesh.

3.2 FIELD QUALITY CONTROL

A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected and work removed and replaced with work that conforms to this Specification.

B. Insulation shall be installed in accordance with Duct Liner Application Standard SMACNA Manual 15.

3.3 ADJUSTING, CLEANING

A. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty.

END OF SECTION 23 0718

SECTION 23 0720 - REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Insulation shall have flame-spread rating of 25 or less and a smoke density rating of 50 or less as tested by ASTM E-84 method.

B. Ratings:
1. Upper rating of =210 deg. F.
2. Lower rating of -110 deg. F.
3. UV stabilized for ten year life.
4. Thermal conductivity of 0.24.
5. Water vapor transmission of .03 perms per inch.
6. Material to be polyolefin food grade.

PART 2 - PRODUCTS

2.1 FLEXIBLE FOAMED PIPE INSULATION

A. Thickness:
1. 1/2 inch for one inch outside diameter and smaller pipe.
2. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
3. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch).
4. One inch sheet for fittings as recommended by Manufacturer.

B. Approved Manufacturers:
1. Armaflex
2. Halstead "Insul-tube"
3. Rubatex
4. Therma-Cel

2.2 JOINT SEALER

A. Approved Manufacturers:
1. Armaflex 520
2. BFG Construction Adhesive #105
3. Therma-Cel 950.

2.3 MANUFACTURED UNITS

A. Nominal 3/4" wall thickness

B. Approved Manufacturers:

1. ImcoLock Pipe Insulation
2. or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.

B. Insulation shall be slipped onto pipe prior to connection or applied after pipe is installed, at contractor's option.

C. Close butt joints and miter joints.
   1. Approved Manufacturers:
      a. IMCOA's Fuse-Seal joining system
      b. or factory approved contact adhesive

D. Insulation shall be installed according to manufacturer's recommended procedures.

E. Exterior exposed Insulation shall be finished with two coats of factory approved finish. Color shall be selected by the Owner's representative.

F. Stagger joints on layered insulation.

G. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.

H. Seal joints in insulation.

I. Insulate flexible pipe connectors.

J. Insulate thermal expansion valves with insulating tape.

K. Insulation exposed outside building shall have "slit" joint seams placed on bottom of pipe.

L. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END OF SECTION 23 0720

SECTION 23 0800 – FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install fire stopping as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Fire stopping material shall meet ASTM E814, E84 and be UL listed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Material shall be flexible, long lasting, intumescent acrylic seal to accommodate vibration and building movement.

B. Caulk simple penetrations with gaps of 1/4" or less with:
   1. Dow Corning Fire Stop Sealant
   2. Pensil 300

C. Caulk multiple penetrations and/or penetrations with gaps in excess of 1/4" with:
   1. Dow Corning Fire Stop Foam
   2. Pensil 200
   3. IPC flame safe FS-1900
   4. Tremco “Tremstop 1A”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's installation instructions explicitly.

B. Seal penetrations of ductwork, piping, and other mechanical equipment through one-hour and two-hour rated partitions as shown on Architectural and Mechanical Drawings.

C. Install fire stopping material on clean surfaces to assure adherence.

END OF SECTION 23 0800

SECTION 23 2166 - SPLIT SYSTEM HEAT PUMP UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install heat pumps as described in Contract Documents.

B. Related Sections
   1. Section 02776 - Concrete pads
   2. Section 23 0100 - Common HVAC Requirements

1.2 SUBMITTALS

A. Quality Assurance / Control - Equipment check-out sheets

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies - Each unit shall be UL or ETL labeled.

1.4 WARRANTY

A. Provide five year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heat Pumps
   1. Indoor Units -
      a. Compact wall mounted units.
      b. Supplementary electric heater, size as scheduled.
      c. Cabinet finish as selected by Architect.
      d. Isolate moving parts from cabinets to reduce noise.
   2. Outdoor Units -
      a. Compressor shall be of rotary or scroll design.
      b. Fans shall be direct driven and discharge horizontally.
      c. Casing shall be fully weatherproof for outdoor installations.
      d. Microprocessor Controls shall be factory wired with field installed remote pendant station.
      e. Refrigerant shall be R-410A.
      f. Isolate moving parts from cabinets to reduce noise.
      g. Use dry-charged tubing for connection of unit's refrigerant system.
   3. Approved Products -
      a. Carrier Corp, Syracuse, NY (800) 227-7437 or (315) 432-6000 www.carrier-commercial.com
      b. Friedrich Air Conditioning Co, Austin, TX (800) 541-6645 or (210) 225-2000 www.friedrich.com
      c. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA (800) 421-1140 or (770) 448-1268
      d. Sanyo Air Conditioning Products, Chatsworth, CA (818) 998-7322 www.sanyo.com
      e. L.G. Electronics, USA, Englewood Cliffs, NJ (201) 585-0018, www.lghvac.com

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service - Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION 23 2166

SECTION 23 2300 - REFRIGERANT PIPING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install piping for refrigeration systems as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Qualifications:
1. Refrigerant piping shall be installed by a refrigeration contractor licensed by State.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING

A. Meet requirements of ASTM B 280-88, "Specification for Seamless Copper Tube for Air Conditioning & Refrigeration Field Service", hard drawn straight lengths.

B. Do not use pre-charged refrigerant lines.

2.2 REFRIGERANT FITTINGS

A. Wrought copper with long radius elbows.

B. Approved Manufacturers:
1. Mueller Streamline
2. Nibco Inc
3. Grinnell
4. Elkhart Products Corp

2.3 CONNECTION MATERIAL

A. Brazing Rods:
1. Copper to Copper Connections:
2. AWS Classification BCuP-4 Copper Phosphorus (6% silver).
3. AWS Classification BCuP-5 Copper Phosphorus (15% silver).
4. Copper to Brass or Copper to Steel Connections:
5. AWS Classification BAg-5 Silver (45% silver).
6. Do not use rods containing Cadmium.

2.4 FLUX

A. Approved Manufacturers:
1. "Stay-Silv white brazing flux" by J W Harris Co
2. High quality silver solder flux by Handy & Harmon

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install refrigerant piping underground or in tunnels.

B. Slope suction lines down toward compressor one inch/10 feet.

C. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary.
   1. No soft solder (tin, lead, antimony) connections will be allowed in system.

D. Braze valve, sight glass, and flexible connections.

E. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

3.2 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of Architect's Engineer after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.
   1. Draw vacuum on each entire system with vacuum pump to 200 microns using vacuum gauge calibrated in microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum. Isolate compressor from system piping using shut-off valves prior to pulling vacuum.
   2. Break vacuum with freon to be used and re-establish vacuum test. Vacuum shall hold for 24 hours at 200 microns without compressor running.
   3. Conduct tests at 70 deg F ambient temperature minimum.
   4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
   5. After testing, fully charge system with refrigerant and conduct test with Halide Leak Detector.

END OF SECTION 23 2300

SECTION 23 2310 - REFRIGERANT SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install refrigeration specialties as described in Contract Documents except for expansion valves on 2 through 5 ton condensing units.

PART 2 - PRODUCTS

2.1 EXPANSION VALVES

A. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.

B. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.

C. Approved Manufacturers:
1. Alco
2. Henry
3. Mueller
4. Parker
5. Singer
6. Sporlan

2.2 FILTER-DRIER

A. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.

B. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.

C. Size shall be full line size.

D. Approved Manufacturers:
1. Alco
2. Mueller
3. Parker
4. Sporlan
5. Virginia

2.3 SIGHT GLASS

A. Combination moisture and liquid indicator with protection cap.

B. Sight glass shall be full line size.

C. Sight glass connections shall be solid copper or brass, no copper-coated steel sight glasses allowed.

D. Approved Manufacturers:
1. Alco
2. Mueller
3. Parker
4. Superior
5. Virginia

2.4 MANUAL REFRIGERANT SHUT-OFF VALVE

A. Ball valves designed for refrigeration service and full line size.

B. Valve shall have cap seals.

C. Valves with hand wheels are not acceptable.

D. Provide service valve on each liquid and suction line at compressor.

E. If service valves come as integral part of condensing unit, additional service valves shall not be required.

F. Approved Manufacturers:
1. ConBraCo (Apollo)
2. Henry
3. Mueller
4. Superior
5. Virginia

2.5 FLEXIBLE CONNECTORS

A. Provide in each liquid line and suction line at both condensing unit and evaporator on systems larger than five tons.

B. Anchor pipe near each flexible connector.

C. Connectors shall be for refrigerant service with bronze seamless corrugated hose and bronze braiding.

D. Approved Manufacturers:
1. Anaconda "Vibration Eliminators" by Anamet
2. Vibration Absorber Model VAF by Packless Industries
3. Vibration Absorbers by Superior Valve Co
4. Style "BF" Spring-flex freon connectors by Vibration Mountings

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.

END OF SECTION 23 2310

SECTION 23 3114 - LOW-PRESSURE STEEL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install above-grade ductwork and related items as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Fabricate of zinc-coated lockforming quality steel sheets meeting requirements of ASTM 653A/653M, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", with G 60 coating.

B. Use of aluminum, non-metallic, or round ducts is not permitted. [Specification writer: Use of aluminum ducts in areas with high chlorine content (eg.: ventilation for pools, spas, etc.) should be considered on a per job basis.]

2.2 DUCT JOINTS

A. Ducts with sides up to and including 36 inches shall be as detailed in the SMACNA manual.

B. Duct sizes over 36 inches shall be fabricated using SMACNA T-24 flange joints or pre-fabricated systems as follows:
   1. Ducts with sides over 36 inches to 48 inches:
      a. transverse duct joint system by Ductmate/25, Nexus, Ward, or WDCI (Lite) (SMACNA "E" or "G" Type connection).
   2. Ducts 48 inches & larger:
      a. Ductmate/35, Nexus, or WDCI (Heavy) (SMACNA "J" Type connection).
   3. Approved Manufacturers:
      a. Ductmate Industries Inc, 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308
      b. Nexus, Exanno Corp, P O Box 729, Buffalo, NY 14206 (716) 849-0545
      c. Ward Industries Inc, 1661 Lebanon Church Road, Pittsburg, PA 15236 (800) 466-9374
      d. WDCI, P O Box 10868, Pittsburg, PA 15236 (800) 245-3188

2.3 ACCESS DOORS IN DUCTS

A. At each manual outside air damper and at each motorized damper, install factory built insulated access door with hinges and sash locks. Locate doors within 6 inches of installed dampers. Construction shall be galvanized sheet metal, 24 ga minimum.

B. Fire and smoke damper access doors shall have a minimum clear opening of 12" x 12" or as specified on Drawings to easily service fire or smoke damper. Doors shall be within 6 inches of fire and smoke dampers and in Mechanical Room if possible.

C. Identify each door with 1/2" high letters reading “smoke damper” or “fire damper”.

D. Approved Manufacturers:

1. AirBalance - Fire/Seal #FSA 100
2. Air Control Products - HAD-10
3. Cesco-Advanced Air - HAD-10
4. Elgen - Model 85 A
5. Kees Inc - ADH-D.
6. Louvers & Dampers - #SMD-G-F
7. Nailor-Hart Industries Inc - Series 0831
8. National Controlled Air Inc - Model AD-FL-1

2.4 FLEXIBLE EQUIPMENT CONNECTIONS

A. 30 oz closely woven UL approved glass fabric, double coated with neoprene.

B. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250 deg F.

C. Approved Manufacturers:
1. Cain - N-100
2. Duro Dyne - MFN
3. Elgen - ZLN
4. Ventfabrics - Ventglas

2.5 CONCEALED CEILING DAMPER REGULATORS

A. Approved Manufacturers:
1. Cain
2. Duro Dyne
3. Metco Inc
4. Vent-Lock - #666
5. Young - #303

2.6 VOLUME DAMPERS

A. In Main Ducts:
1. 16 gauge galvanized steel, opposed blade type with 3/8 inch pins and end bearings. Blades shall have 1/8 inch clearance all around.
2. Damper shall operate within acoustical duct liner.
3. Provide channel spacer equal to thickness of duct liner.
4. Approved Manufacturers:
   a. Air Balance - Model AC-2
   b. Air Control Products - CD-OB
   c. American Warming - VC-2-AA
   d. Greenheck - VCD-1100
   e. NCA, Safe Air
   f. Vent Products - 5100

B. In Sheet Metal Branch Ducts:
1. Extruded aluminum, opposed blade type. When in open position, shall not extend beyond damper frame.
2. Maximum blade length 12 inches.
3. Damper Regulator shall be concealed type with operation from bottom or with 90 deg miter gear assembly from side.
4. Approved Manufacturers:
   a. Air Control Products - TCD-OB
   b. Air Guide - OB
   c. Arrow - OBDAF-207

d. CESCO - CDA
e. Reliable Metals - OBD-RO
f. Tuttle & Bailey - A7RDDM
g. Safe Air
h. Young - 820-AC

C. Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, provide concealed ceiling damper regulator and cover plate.

2.7 MOTORIZED OUTSIDE AIR DAMPERS

A. Damper Blades:
1. 18 gauge galvanized steel or equivalent aluminum with replaceable rubber blade edges, 9 inches wide maximum.
2. End seals shall be flexible metal compression type.
3. Opposed blade type.

B. Make provision for damper actuators and actuator linkages to be mounted external of air flow.

C. Approved Manufacturers & Models:
1. Air Balance - AC-2
2. American Warming - VC-2-AAVA
3. Arrow - OBDAF-207
4. Greenheck - VCD-2100
5. Honeywell - D641
6. Johnson - D1300
7. Louvers & Dampers - TSD400
8. Ruskin - CD36 or CD60
9. Safe Air - 610
10. Vent Products - 5800

2.8 BACKDRAFT DAMPER

A. Backdraft blades shall be nonmetallic and shall be neoprene coated fiberglass.

B. Stop shall be galvanized steel screen or expanded metal, 1/2 inch mesh.

C. Frame shall be galvanized steel or extruded aluminum alloy.

D. Approved Models & Manufacturers:
1. Air Control Products - FBD
2. American Warming - BD-15
3. CESCO - FBD 101
4. Ruskin - NMS2
5. Safe Air

2.9 DUCT HANGERS

A. 1" x 18 gauge galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 8 feet apart. Do not use wire hangers.

B. Attaching screws at trusses shall be 1-1/2 inch No. 10 round head wood screws. Nails not allowed.

2.10 DUCT SEALER

A. Cain - Duct Butter or Butter Tak

B. Design Polymerics - DP 1010

C. DSC - Stretch Coat

D. Duro Dyne - S2

E. Hardcast - #601 Iron-Grip or Peel-N-Seal Tape
1. Kingco - 15-325
2. Mon-Eco - 44-41
3. Trans-Continental Equipment Co - Multipurpose Duct Sealant
4. United - Sheet Metal duct-sealer

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ducts:
1. Straight and smooth on inside with joints neatly finished unless otherwise directed.
2. Duct panels through 48 inch dimension having acoustic duct liner need not be crossbroken or beaded.
3. Crossbreak unlined ducts and duct panels larger than 48 inch or bead 12 inches on center.
4. Securely anchor ducts to building structure with specified duct hangers attached with screws. Do not hang more than one duct from a duct hanger.
5. Brace and install ducts so they shall be free of vibration under all conditions of operation.
6. Ducts shall not bear on top of structural members.
7. Make duct take-offs to branches, registers, grilles, and diffusers as detailed on Drawings.
8. Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
9. Properly flash where ducts protrude above roof.
10. Install internal ends of slip joints in direction of flow. Make joints air tight using specified duct sealer.
11. Cover horizontal and longitudinal joints on exterior ducts with two layers of Hardcast tape installed with Hardcast HC-20 adhesive according to Manufacturer's recommendations.
12. Paint ductwork visible through registers, grilles, and diffusers flat black.

B. Install flexible inlet and outlet duct connections to each furnace, fan, fan coil unit, and air handling unit.

C. Install concealed ceiling damper regulators.
1. Paint cover plates to match ceiling tile.
2. Damper regulators will not be required for dampers located directly above removable ceilings or in Mechanical Rooms.

D. Provide each take-off with an adjustable volume damper to balance that branch.
1. Anchor dampers securely to duct.
2. Install dampers in main ducts within insulation.
3. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
4. Where concealed ceiling damper regulators are installed, provide a cover plate.

E. Install grilles, registers, and diffusers. Level floor registers and anchor securely into floor.

F. Air Turns:
1. Permanently installed, consisting of single thickness curved metal blades with one inch straight trailing edge to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
2. 4-1/2 inch wide minimum vane rail. Do not use junior vane rails.

3. Double thickness vanes not acceptable.
4. Quiet and free from vibration when system is in operation. See SMACNA Manual

G. Install motorized dampers

END OF SECTION 23 3114

SECTION 23 3346 - FLEX DUCT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install supply air branch duct runouts to diffusers as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Formable, flexible, circular duct which shall retain its cross-section, shape, rigidity, and shall not restrict air flow after bending.

B. Nominal 1-1/2 inches thick, 3/4 lb/cu ft density fiberglass insulation with air-tight, polyehtylene or polyester core, sheathed in seamless vapor barrier jacket factory installed over flexible assembly.

C. Assembly, including insulation and vapor barrier, shall meet Class I requirement of NFPA 90A and be UL 181 rated, with flame spread of 25 or less and smoke developed rating of 50 or under.

D. Length of flexible ductwork shall not exceed 8'-0".

2.2 APPROVED MANUFACTURERS

A. ANCO-FLEX - 4625

B. Flex-Aire - PF/UPC #090

C. Hart & Cooley - F114

D. Thermaflex - G-KM

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct in fully extended condition free of sags and kinks.

B. Make duct connections by coating exterior of duct collar for 3 inches with duct sealer and securing duct in place over sheet metal collar with 1/2 inch wide metal cinch bands and sheet metal screws.

END OF SECTION 23 3346

SECTION 23 3400 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install exhaust fans as described in Contract Documents.

1.3 QUALITY ASSURANCES

A. Requirements of Regulatory Agencies:
   1. Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED EXHAUST FANS

A. Acoustically insulated housings.

B. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.

C. Include chatterproof integral back-draft damper with no metal to metal contact.

D. True centrifugal wheels.

E. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.

F. Suitably ground motors and mount on rubber-in shear vibration isolators.

G. Provide wall or roof cap, as required.

H. Approved Manufacturers:
   1. Cook-Gemini
   2. Greenheck Sp
   3. Pace
   4. Penn Zephyr
   5. Twin City

2.2 ROOF MOUNTED EXHAUST FANS

A. Direct drive or have adjustable pitch V-belt as noted on Drawings.

B. Wheels shall be backward curved and housing shall be removable or hinged aluminum.

C. Isolate motor with vibration dampeners.

D. Provide quiet type back-draft dampers.

E. Insulated, pre-fabricated metal roof curb shall be for flat or sloped roof as shown on Drawings.

F. Approved Manufacturers:
   1. Fans:
      a. Penn
      b. Centri-Master
      c. Cook
      d. Greenheck G, GB
      e. Twin City
   2. Standard curbs:
      a. Penn
      b. Cook
      c. Greenheck
   3. Sound attenuating curbs:
      a. Penn
      b. Greenheck

2.3 CENTRIFUGAL IN-LINE FANS

A. Non-overloading design and of arrangement indicated.

B. Constructed of low carbon steel and painted with an approved rust resistant coating or all aluminum as shown.

C. Fan performance shall be based on tests conducted in accordance with the AMCA Standard test code of air moving devices and shall be licensed to bear the AMCA Certified Air and Sound Rating Seal. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise well beyond the efficiency peak to assure quiet and stable operation under all conditions. Horsepower characteristics shall be truly self-limiting and shall reach a peak in the normal selection area.

D. Wheel diameters shall be in accordance with the standard sizes adopted by AMCA for centrifugal in-line type fans. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration or pulsation. Housings shall be arc welded steel throughout.

E. Fan wheel shall include die formed AIRFOIL blades designed for maximum efficiency and quiet operation. Blades shall be continuously welded to back plate and welded to wheel cone. Class 2 fan with inlet and outlet bell fittings.

F. Wheels shall be statically and dynamically balanced and assembled fan shall be tested for balance at specified speed at the factory prior to shipment. Such tests shall be performed with an IRD analyzer to measure radial and axial displacements.

G. Bearings are to be ball or roller anti-friction type, and shall be equipped with extended lubrication lines to grease fittings outside of the fan housing. Shafts shall operate at no more than 70% of first critical speed to assure smooth operation.

H. Accessories for in-line fans to include belt guard, inlet and outlet flanges, and other accessories as called for in the plans.

I. All fans shall be equipped with an adjustable motor base integral with the fan housing. This motor base shall be completely welded and consist of frame and reinforcing side sheets to assure maximum strength and rigidity.

J. Submittals for approval of equipment shall include copies of outline drawings, AMCA Certified Sound Ratings, and percentage pressure-volume performance curves showing point of operation.

K. Approved Manufacturers:
   1. Barry

2. Cook
3. Penn

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor fan units securely to structure or curb.

END OF SECTION 23 3400

SECTION 23 3713 - AIR OUTLETS & INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install wall supply registers, transfer grilles, return air grilles, soffit grilles, ceiling diffusers, louvers connected to ductwork, and registers as described in Contract Documents.

PART 2 - PRODUCTS

2.1 GRILLES & REGISTERS

A. Approved Manufacturers:
1. Price
2. Anemostat
3. Krueger
4. Titus
5. Tuttle & Bailey

2.2 SPIN-IN FITTINGS

A. Low pressure round take-offs to diffusers shall be made with spin-in fittings. They shall incorporate a manual balancing damper. The damper shall be spring loaded and a positive locking wing nut shall secure the damper position.

B. Approved Manufacturers:
1. Sheet metal fittings: Genflex DB-1DEL, Hercules

2.3 LOUVERS

A. Extruded aluminum, with blades welded or screwed into frames and 1/2 inch mesh 16 gauge aluminum bird screen.

B. Frames shall have mitered corners.

C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.

D. Approved Manufacturers:
1. Airolite
2. American Warming
3. Arrow
4. Industrial Louvers
5. Ruskin
6. Vent Products

2.4 ROOF MOUNTED INLETS AND OUTLETS

A. FABRICATION

1. Penthouse type of extruded aluminum complete with roof curb to fit slope of roof and ½ inch mesh 16 gauge aluminum bird screen.

B. APPROVED MANUFACTURERS & MODELS
   1. Tiered Type:
      a. Model TRE extruded aluminum ventilator by Loren Cook Company, Springfield Missouri
   2. Louvered Penthouse
      a. Penn “Penhouse”
      b. Model WRH by Greenheck Fan Corporation, Schofield, WI
      c. Model MPH by Jenn-Air Industries Inc., Indianapolis, IN

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings.

B. Install with screws to match color and finish of grilles and registers.

C. Touch-up any scratched finish surfaces.

D. Install in accordance with manufacturer's instructions.

E. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

F. Install diffusers to ductwork with air tight connection.

G. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.

H. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9000.

END OF SECTION 23 3713

SECTION 23 5540 - ELECTRIC RADIANT WALL HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install wall heaters as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fan type for recess mounting in wall.

B. 20 gauge minimum sheet metal casing.

C. Heating element shall be encased in steel finned casting and protected by thermal switch.

D. Fan motor shall be heavy duty enclosed and permanently lubricated.

E. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.

F. Units shall be controlled automatically by integral thermostat when heater is in "ON" position.

G. Heater shall have built-in fan delay.

H. Finish - Baked-on enamel.

I. Approved Manufacturers:
   1. Q' Mark
   2. Berko
   3. Thermador
   4. Markel

END OF SECTION 23 5540

SECTION 23 7413 - PACKAGED TERMINAL AIR CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, and Section 23 0501 apply to this Section.

1.2 SUMMARY

A. Furnish and install complete packaged thru-the-wall heating/cooling unit as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Thru-the-wall heating/cooling unit complete with integral thermostat and push button controls.

B. Unit shall be electric heat and electric air conditioning complete with:
   1. Extruded aluminum fresh air intake
   2. Motorized fresh air damper
   3. Heavy steel wall sleeve
   4. Insulated cabinet

C. Unit capacity shall be as shown on the drawings.

D. Approved Manufacturers:
   1. GE.
   2. Trane
   3. Carrier
   4. Or approved equal

END OF SECTION

SECTION 23 7433 - FACTORY FABRICATED PACKAGED, 100% OUTDOOR, HEATING AND COOLING MAKEUP AIR UNITS (DOAS)

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged heating and cooling units capable of supplying 100 percent outdoor air.

B. Units to be manufactured by Trane, Carrier, Captive Air, or prior approved equal.

1.2 SUBMITTALS

A. Provide Factory Submittals to the Engineer.

1.3 QUALITY ASSURANCE

A. All models shall be ETL listed and comply with safety standards UL 1995, and CSA Std. C22.2, No. 236-11. Units outfitted with indirect fired heaters shall also comply with ANSI Z83.8-2013, and CSA 2.6-2013.

1.4 WARRANTY

A. All units shall be provided with the following standard warranties:
1. 10-Year (non-prorated) parts warranty covering the entire unit when accompanied by a company provided service plan. 5-Year (non-prorated) parts warranty covering the entire unit otherwise.
2. 25-year (non-prorated) parts warranty for SS heat exchanger on indirect fired units.

B. This warranty shall not apply if:
1. The equipment is not installed by a qualified installer per the manufacturer's installation instructions shipped with the product.
2. The equipment is not installed in accordance with federal, state and local codes and regulations.
3. The equipment is misused or neglected, or not maintained per the manufacturer's maintenance instructions.
4. The equipment is not operated within its published capacity.
5. The invoice is not paid within the terms of the sales agreement.

C. The manufacturer shall not be liable for incidental and consequential losses and damages potentially attributable to malfunctioning equipment. Should any part of the equipment prove to be defective in material or workmanship within the 10 year period, upon examination by the manufacturer, such part will be repaired or replaced by manufacturer at no charge. The buyer shall pay all labor costs incurred in connection with such repair or replacement. Equipment shall not be returned without manufacturer's prior authorization and all returned equipment shall be shipped by the buyer, freight prepaid to a destination determined by the manufacturer.

PART 2 - PRODUCTS

2.1. GENERAL

A. Supply single zone one piece packaged units that are complete as per the following specification, deliver all capacities scheduled, and conform to design indicated herein.

2.2. CABINET

A. Unit(s) shall be constructed of minimum 20ga. G-90 galvanized steel riveted together via structural pop-rivets. All metal shall be CNC bent for precise assembly.
1. Rigging Provisions: The unit shall have a structural base constructed of minimum 14ga. G-90 galvanized steel, and include full sized fork pockets and lifting points on all four sides.
2. Roof Construction: The lids shall be fabricated by forming a double-standing, self-locking seam that requires no additional support. Roof shall be pitched to allow for proper drainage.
3. Exterior Wall Construction: All exterior walls shall consist of a double wall, G-90 galvanized steel construction insulated with 2in. thick, foil-faced, R13 closed cell foam.
4. Service Access Doors: All door jambs shall be gasketed around their perimeter, and allow for doors to be mounted via removable, spring actuated, stainless steel hinges with stainless steel rivets, and self-compressing latches. Each compartment shall have removable access panels to allow for ease of service and maintainability. Electrical cabinet access doors shall have a door hold installed to prop doors open. All doors shall have stainless steel latches which are pad lockable. Electrical cabinet doors shall be outfitted with schematic/manual pouches formed into the door, along with wiring diagram attached to the indoor of the door from the factory.

B. Entire interior and exterior casing shall be constructed of minimum 20 GA G90 galvanized steel with no painting, and shall have surpassed a salt spray corrosion test as per ASTM B 117.

2.3. AIRFLOW CONFIGURATION

A. Unit shall be configurable for both down (vertical) discharge through base of unit, or side discharge through the cabinet. Unit shall also be configurable to both down (vertical) return or side return into the cabinet.

B. Unit intake airflow configuration shall be through use of a fresh/outdoor air damper.
1. Damper: Shall exceed AMCA Class 1A standard for low leakage. Damper assembly shall be a single assembly, and outfitted with an integral bird screen and louver/gutter system to divert any drainage through the base of the unit – intake air hood not required.
2. Actuator: A single direct drive damper actuator shall be used with spring return to ensure that the outdoor air section closes when not powered.

2.4. SUPPLY AIR BLOWER AND MOTOR

A. All supply fans shall be direct drive (belt-driven not acceptable) variable speed plenum fans.

B. Blower Motor: Motor shall be a premium efficiency motor available as:
1. Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC) motor driven by a Variable Frequency Drive.
2. Electronically Commutated Motor (ECM).

C. Fans to be selected at or near efficiency peak. (Submit fan curves.)

D. Blower and motor assembly shall be dynamically balanced. The entire blower and motor assembly shall be mounted on rubber vibration isolators. Wheels balanced as per AMCA 204+96, Balance Quality and Vibration Levels for fans.

2.5. REFRIGERATION SYSTEM

A. Unit shall utilize a variable speed inverter duty scroll compressor with the following features:

1. Modulation: Compressor shall be capable of compressor speed modulation from 15%-100% on 8, 10, & 12.5 Ton units, and 25%-100% on 15, 20, 22, 25, & 30 Ton units.
2. Refrigerant: Unit shall be factory charged with R410A refrigerant.
3. Vibration Isolation: Compressor shall be mounted on rubber vibration isolators to reduce transmission of vibration to the building structure.
4. Internal Overload Protection: Compressor shall include internal thermal overload production to protect against excessive motor temperatures.
5. Crankcase Heater: Compressor shall include a crankcase heater to protect against liquid flood-back and elimination of oil foaming on startup. The crankcase heater must remain powered when compressor is not in operation.
6. Oil Management: Unit shall utilize both passive and active oil return management using Oil Level Sensor and scheduled oil boosts.
7. Monitored Envelope: Unit shall monitor all critical refrigeration points to ensure compressor does not operate outside of safe operating envelope.
8. Throttling Logic: Unit shall allow for high head pressure monitoring throttle mode for high ambient operation, and low suction pressure throttle mode for low capacity operation or any conditions resulting in low suction pressure.
9. Pump-Down: Active pump-down mode with discharge line check valve to protect against liquid migration into compressor during idle times.
10. Defrost mode in optional Heat Pump: When outdoor coils are deemed at risk of freezing, the unit shall simultaneously turn on auxiliary heat while running the heat pump in "cooling" mode to help defrost outdoor coils as needed while still maintain desired leaving air temperatures.

B. The unit shall be outfitted with the following:
1. Indoor Coil: Indoor coil shall be a high efficiency 5-7 row coil design with aluminum fins mechanically bonded to copper tubes. Coil is staggered to increase turbulence, reduce the coil bypass factor, and ultimately the time the air stays within the coil.
2. Electronic Expansion Valve: Each refrigeration circuit will be outfitted with an electronic expansion valve metering device which can be throttled from 0-100% open to allow for precise superheat control.
3. Indoor Coil Drain Pan: The indoor coil shall be outfitted with a sloped stainless steel drain pan. This pan shall be insulated along the entire base to prevent condensation, and outfitted with a safety overflow switch which will automatically shut down cooling operation prior to water overflowing the drain pan in the event of a drain clog. The entire drain pan shall be 20 GA Stainless Steel construction and wrap beneath the entire coil with flashing on entering side of coil to ensure capture of all condensate. Drain pan discharge pipe shall also be stainless steel construction. Drain pan shall be pitched to exceed ASHRAE 62.1 standard.
4. Base of the condensing coil cabinet shall be pitched away from the unit as a safety to ensure all draining exits away from the curb.
5. Hot Gas Reheat Coil: The unit shall include an copper tube and aluminum fin hot gas reheat coil mounted downstream of the indoor coil. This coil shall be controlled via fully modulating hot gas reheat valve to provide precise reheat temperature control. This coil shall include the addition of an evaporative coil leaving condition sensor to maintain a coil dew point. This also prevents operation of a dehumidification call when intake dew point conditions are found to be below space dew point conditions, preventing wasted energy.
6. Outdoor (Condenser) Coil: Outdoor coil shall be a high efficiency coil design with aluminum fins mechanically bonded to copper tubes. The coil shall be downward sloped to protect coil from hail damage. Optional hail guards may also be outfitted to the outdoor coil for added protection from hail bouncing off of the roof of the unit up the coil.
7. Outdoor Fans: The outdoor coil shall have a vertical discharge outfitted with quiet, efficient, fully modulating Electronically Commutated Motor (ECM) condensing fans. These fans shall modulate to maintain a temperature differential between outside air and the outdoor coil.

C. To help mitigate any long-term potential for leaks or hardware failures, the unit shall be outfitted with the following protection measures:
1. Suction line accumulator for added protection against liquid entering suction line of compressor.
2. Bi-flow, low pressure drop, filter drier.
3. Electronic Expansion Valve (EEV) for precise superheat control. EEV shall open partially allowing system pressure equalization prior to activation of the compressor.
4. On optional heat pump units, use of a single 3-way reheat valve to prevent obstructions due to valve failure.
5. Protective rubber sleeves installed on all distribution lines of indoor coil to prevent wear from rubbing.
6. All refrigeration ports shall be short-stub assembly and any access port with a transducer or switch is mounted vertically to mitigate risk of bent/cracked stub joints.
7. Refrigeration circuit shall be mechanically CNC pre-bent tubing wherever possible with minimal brazed joints to minimize points for potential refrigeration leaks.
8. Factory tested for leaks via high pressure nitrogen decay and helium tracer gas testing.
9. Suction line temperature sensor failure detection.
10. Preventative failure alerts through a manufacturer provided, cloud based, cellular remote monitoring system.

2.6. HEATING SYSTEM

A. The gas burner shall be an indirect-fired, push-through type, using (natural) (LP) gas at an inlet-supply pressure to the unit of 7”w.c. minimum Nat. Gas, (11"w.c. minimum LP Gas).

B. Burner shall be a tubular in-shot fired design capable of using natural or LP type gas. Each burner ignition shall be of the direct-spark design with remote flame sensing at inlet of the last firing tube of the gas manifold.

C. Direct-sparking sequence shall last through the complete duration of the trial for ignition period for guaranteed light-off. Burner shall always be lit at maximum gas flow and combustion airflow for guaranteed light-off. Each burner ignition module shall have LED indicators for troubleshooting and a set of exposed prongs for testing flame indication signal.

D. All furnaces shall be controlled by an electronic Vernier-type fully modulating control system capable of achieving 80% combustion efficiency over the entire gas firing range of the unit.

E. Each furnace shall have:
1. A minimum turndown ratio of 6:1 for natural gas and 5:1 for LP gas while maintaining a constant 80% efficiency (90% for high efficiency furnace option). No cold air bypass of the heat exchanger.
2. Each furnace heat exchanger shall be a bent-tube style design made entirely of type 409 stainless steel.
3. Stainless steel Quick Seal Connection for gas connection.
4. Manifold and Input gas pressure gauges.
5. Factory piped condensate drain to exterior of cabinet.
6. A combustion flue to be installed on adjacent side as combustion intake with integrated high velocity wind cap.
7. A blocked vent safety airflow switch with high temperature silicone tubing operating off of absolute pressure measured inside of the power-vent blower housing.
8. A high temperature auto-recycling limit with a maximum non-adjustable set point.
9. A manual reset high temperature flame roll out switch with a non-adjustable set point.
10. Each furnace compartment shall have a removable post and panel that allows the furnace to be easily removed for service and maintainability.
11. A power-vent assembly for exhausting flue gases with a PSC or ECM type motor that is securely mounted and easily accessible/removable for service.

12. A 0-10”w.c. gas pressure gauge installed on the gas manifold.

B. Each electric heater shall have:
1. SCR electric inserts for side or discharge supply.
2. Electric coils are controlled using SCR controls. SCR is a time proportioning type controller that modulates the heater and supplies the exact amount of power to match the heat demand with a 10:1 turndown per stage with full modulation between minimum turndown and max output.

2.7. FILTERS

A. Provide filters as part of unit. All filters shall be furnished and installed to meet the performance requirements set forth in the schedule and as specified under another section of this work.

B. All filters shall be installed on tracks for easy removal from the unit.

C. Up to 3 layers of outdoor air filtration installed. Unit shall ship with a 2” washable metal mesh outdoor air filter. Mixed air shall have optional 2” MERV-8 and MERV-13 filters , 4” MERV-15 or 4” MERV-17 HEPA filter banks factory installed.

D. Unit shall have an optional adjustable pressure differential sensor for the filter bank to alert in the event of a clogged filter.

2.8. ELECTRICAL

A. All controls shall be pre-wired and housed in an insulated electrical cabinet within the unit to protect against risk of condensation.

B. All direct fired and cooling only units shall be provided with single point electrical connection.

C. Unit shall be provided with a door safety switch that de-energizes the supply fan when the door is opened.

D. Unit shall be provided with a factory mounted averaging supply air temperature sensor to allow for accurate discharge temperature readings within unit when a downstream sensor is not installed. Field mounted and wired discharge air sensors will not be accepted.

E. Unit shall be provided with a factory mounted averaging intake air temperature sensor to allow for accurate intake temperature reading regardless of how the OA/RA dampers are positioned.

F. The electrical cabinet shall be outfitted with the following:
1. LED electrical cabinet service light with automatic activation upon door switch.
2. Color wiring schematics, laminated to the interior wall of the cabinet doors.
3. Factory mounted disconnect with unit bottom knockouts.
4. A LED backlit, LCD Human-Machine Interface (HMI) shall be mounted within the unit’s control cabinet to allow for all set points configuration and refrigeration system monitoring at the unit.
5. Up to 4 additional space mounted HMIs available. Additional HMIs shall allow for full programming capabilities and are outfitted with integral temperature and humidity sensors. Additional HMIs shall be capable of being individually averaged for space temperature/humidity readings. All HMIs shall be wired using standard CAT5/6 cables.

6. Optional 120V, 15A unit powered or unpowered convenience outlet.

G. All sensors shall be wired back to the main control board that continuously monitors all critical components and makes decisions based on pre-determined logic to accurately control the following:
1. PID logic to control heater modulation ensuring precise discharge/space temperature control.
2. PID logic to control compressor speed to provide precise control over evaporative coil temperatures, leaving dew point, and discharge/space temperatures.
3. PID logic for Outdoor fan modulation to maintain an optimal outdoor coil temperature.
4. PID logic for Electronic Expansion Valve (EEV) position to maintain a precise superheat temperature
5. PID logic for Modulating Reheat valve to limit supply air temperature and relative humidity based off of space or discharge conditions.

2.9. CONTROLS

A. Unit shall be outfitted with a control board to allow for full control of the entire unit.

B. Provide air flow switch on the supply fan system to sense air flow with available set of contacts for connection to BMS for airflow alerts.

C. All unit controls shall be compatible with BACnet and LonWorks based building management systems.

D. All units shall be outfitted with CASLink cloud based monitoring, which monitors every point of operation. Provides configurable automated fault alert e-mails, and remote control capabilities.

E. Integrated cellular module to provide remote connection to monitoring services to view both real time and historical unit operation. Data shall be stored a minimum of 3 years on the cloud. Data sample rate shall be a maximum of 60 seconds.

F. Temperature Control System
1. **Low-Ambient Cooling:** Unit is factory outfitted with logic allowing for low-ambient operation of the DX system down to 15F outdoor temperatures purely through software utilizing the standard factory modulating components.
2. **Discharge Temp Control (Heating):** Unit modulates the burner flame (current supply in the case of electric heating) to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using heating PID controls designed specifically for the DOAS.
3. **Discharge Temp Control (Cooling):** Unit modulates the compressor frequency to accurately maintain the desired discharge temperature set point and compensate for fluctuations in entering air temperature, air volume and % of OA using proprietary cooling PID controls designed specifically for the DOAS.
4. **Discharge Humidity Control (Dehumidification):** Unit modulates the compressor frequency to accurately maintain a desired evaporative coil dew point measured via a coil mounted temperature sensor between the evaporative and hot gas reheat coils. A fully modulating hot gas reheat valve shall utilize excess waste heat from the condensing section feed the hot gas reheat coil with the precise amount of heat needed to accurately reheat the airstream in order to maintain a desired discharge temperature compensating for fluctuations in entering air temperature, air volume and % of OA using proprietary dehumidification PID controls designed specifically for the DOAS.
5. **Advanced Total Unit Economizer:** The control system is outfitted standard, without need for any additional hardware, with an Advanced Total Unit Economizer which will take maximum advantage of as much energy available in the outdoor air conditions in order to run the compressor the minimum amount required at any given incoming air

conditions. If the outdoor enthalpy (temperature and relative humidity) permits, the unit will be capable of completely modulating and shutting off compressor to provide "free" cooling and dehumidification as the outdoor air conditions allow.

G. Activation Controls:
1. **Activate Based on Intake (Heating):** Unit will activate heating when the intake temperature drops below the desired set point.
2. **Activate Based on Intake (Cooling):** Unit will activate cooling when the intake temperature rises above the desired set point.
3. **Activate Based on Intake (Dehumidification):** Unit will activate dehumidification when the intake conditions rise above the desired intake set point, with activation set points configured to a Dew Point, Relative Humidity or a combination of Dew Point/Relative Humidity.

2.10. ROOF CURB

A. Unit shall be factory assembled, and constructed of 18GA galvanized steel, with optional 16GA available.

B. Curb shall be fully insulated with 1" acoustical and thermal insulation.

C. Curb shall be factory outfitted with duct support hangers.

2.11. VARIABLE FREQUENCY DRIVES

A. Provide Variable Frequency Drive for the compressor as part of the AC unit. VFD shall be furnished and installed to meet the performance set forth in the schedule and as specified under another section of this work.
1. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure. (The use of more than one enclosure is not acceptable).

B. Provide Variable Frequency Drive for speed control on all non-ECM direct drive supply fans.

C. All VFDs shall provide the following inherent protections:
1. Phase protection
2. Brownout protection
3. Overload/Overheat protection
4. Soft starts to protect bearings/hardware.
5. Low & High voltage & over-torque protections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which packaged units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions, drawings, written specifications, manufacturer's installation manual and all applicable building codes.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. Install piping to allow service and maintenance.

B. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts.

C. Electrical: Conform to applicable requirements in Division 26 Sections.

3.4 SYSTEM START-UP

A. System start up is performed by a factory trained Service Technician

END OF SECTION 23 7433

SECTION 23 8129 - VRF SYSTEM

PART 1 - HEAT PUMP OUTDOOR UNIT:

1.1 GENERAL

A. The outdoor unit shall be used with VRF components of the same manufacturer consisting of the outdoor unit, indoor units, factory designed and supplied Y-branches and/or Headers, and controls.

B. System components shall be of the same manufacturer or as recommended by the manufacturer of the VRF equipment.

C. Unit control boards shall perform all functions required to effectively and efficiently operate the VRF system and communicate in a daisy chain configuration from outdoor unit to indoor units via RS485.

D. The outdoor unit shall be completely factory assembled, piped and wired.

E. Each outdoor unit shall be run tested at the factory.

F. The sum of connected nominal capacity of all indoor air handlers shall range from 50% to 130% of outdoor unit nominal capacity to ensure the VRF system will have sufficient capacity to handle the building space loads at peak design when accounting for building diversity.

G. Outdoor unit shall have a tested sound rating no higher than 51 dB(A) per outdoor unit frame tested per KSA0701. The outdoor unit frame shall include three quiet/nighttime operation settings of 46, 43, and 40 dBA.

H. All refrigerant lines from the outdoor unit to the indoor units shall be field insulated.

I. The outdoor unit shall have an accumulator.

J. The outdoor unit shall have a high pressure safety switch

K. The outdoor unit shall have over-current protection.

L. The outdoor unit shall use a Cyclon type double tube subcooling heat exchanger.

M. The outdoor unit shall have the ability to operate with an elevation difference of up to 164 feet above or 131 feet below the indoor units.

N. The outdoor unit shall allow up to a total equivalent refrigerant piping length of 984 feet.

O. The maximum equivalent piping length from outdoor unit to indoor unit shall be up to 574 feet without traps.

P. The outdoor unit shall be capable of operating in heating only mode down to -4°F and up to 61°F ambient wet bulb without additional low ambient controls.

Q. The outdoor unit shall be capable of operating in cooling only mode down to 23°F and up to 118°F ambient dry bulb.

R. The outdoor unit shall have an oil separator for the compressor and controls to ensure sufficient oil supply is maintained for the compressor.

S. Shall use R410A refrigerant.

T. Each outdoor unit frame shall have a removable service panel with no more than 3 screws to allow access to service tool connection, DIP switches, auto addressing, error codes, printed circuit boards, inverter circuit, and refrigeration circuit components.

1.2 FRAME:

A. Shall be constructed with galvanized steel, bonderized and be finished with powder coat baked enamel paint.

1.3 COMPRESSOR:

A. All 208/230V, 1 phase outdoor unit frames shall be equipped with one hermetic digitally controlled inverter driven rotary compressor.

B. A crankcase heater shall be factory mounted on the compressor.

C. The outdoor unit compressor shall have an inverter to modulate capacity. The frequency of the inverter compressor shall be completely variable from 25 to 90Hz in cooling mode and 25 to 100Hz in heating mode.

D. The compressor shall be equipped with an internal thermal overload.

E. The compressor shall be mounted to avoid the transmission of vibration.

1.4 FAN:

A. All outdoor unit frames shall be furnished with two direct drive, variable speed polymeric propeller type fans.

B. All fan motors shall have inherent protection, have permanently lubricated bearings, and be variable speed with a maximum speed up to 700 rpm in cooling mode and up to 750 rpm in heating mode.

C. All fans shall be provided with a raised guard to limit contact with moving parts.

D. The outdoor unit shall have horizontal discharge airflow.

1.5 COIL:

A. The outdoor coil shall be of nonferrous construction with louvered fins on copper tubing.

B. The coil fins shall have a factory applied corrosion resistant GoldFin™ material with hydrophilic coating.

C. The coil shall be protected with an integral metal guard.

D. Refrigerant flow from the outdoor unit shall be controlled by means of a digitally controlled inverter driven rotary compressor.

1.6 ELECTRICAL:

A. The outdoor unit electrical power shall be 208/230V, 60 Hz, 1 phase.

B. The outdoor unit shall be capable of operation within voltage limits of +/- 10% rated voltage.

C. The outdoor unit shall be controlled by integral microprocessors.

D. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-

conductor, stranded, shielded cable for the RS485 daisy chain communication.

PART 2 - HIGH STATIC CEILING-CONCEALED DUCTED INDOOR UNIT

2.1 GENERAL:

A. High static ceiling concealed duct indoor unit shall mount fully concealed within the ceiling.

B. Shall be designed for use with R410a refrigerant.

C. Shall be installed with heat pump or simultaneous heating and cooling heat pump VRF systems of the same manufacturer.

D. The indoor unit shall communicate with the outdoor unit via RS485 daisy chain communication.

E. Field installed ductwork shall not exceed the external static pressure limitation of the high static ducted indoor unit.

2.2 INDOOR UNIT:

A. The indoor unit shall be factory assembled, wired and run tested.

B. The indoor unit shall be factory wired and piped with its own electronic expansion device, control circuit board, fan and motor.

C. The indoor unit shall have
1. Self-diagnostic function
2. Auto restart function

D. Indoor unit refrigerant circuit shall be filled with a dry nitrogen gas charge from the factory.

2.3 UNIT CABINET:

A. The cabinet shall be ceiling-concealed and ducted.

2.4 FILTER:

A. Return air shall be filtered with a factory supplied removable, washable filter.

B. Return filter box with high-efficiency filter shall be field provided (by contractor) and installed not to exceed external static pressure limitation of the high static ducted indoor unit.

2.5 FAN:

A. The indoor unit fan shall be no more than one assembly with two Sirocco fans direct driven by a single motor.

B. The indoor fan shall be statically and dynamically balanced.

C. Motor shall have permanently lubricated bearings.

D. In cooling mode, the indoor fan shall have the following settings; Low, Med, and High.

E. In heating mode, the indoor fan shall have the following settings; Low, Med, and High.

2.6 COIL:

A. The indoor unit coil shall be nonferrous with louvered fins on copper tubing for maximum efficiency.

B. The tubing shall have inner grooves for high efficiency heat exchange.

C. The coils shall be pressure tested at the factory.

D. A condensate drain pan shall be factory installed below the coil.

E. All refrigerant lines to the indoor units shall be field insulated.

2.7 CONDENSATE PUMP:

A. The unit shall include a factory installed condensate pump that will be able to raise drain water 27 inches above the bottom of the indoor unit.

2.8 ELECTRICAL:

A. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hz.

B. The indoor unit shall be capable of operation within voltage limits of +/-10% rated voltage.

2.9 CONTROLS:

A. Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS485 daisy chain.

END OF SECTION 23 8129

SECTION 23 8416 - DE-HUMIDIFICATION UNITS

PART 1 - GENERAL

1.1. SCOPE

A Furnish and install natatorium environmental control system. Unit shall be specifically designed for natatorium environmental control including dehumidification, and air heating/cooling. The unit shall have fully self-contained microprocessor controller with diagnostics, status reporting and alarm functions.

B. The dehumidifiers shall be single package units. Each unit shall include compressor(s), evaporator (dehumidifying coil), condenser (air reheat coil), supply air blower(s), blower motor(s), motor starters and controls in one complete enclosure.

1.2. QUALITY AND SAFETY ASSURANCE

A. Entire unit shall be ETL listed and/or CSA certified. Units with listed components only shall not be acceptable.

B. Coils shall be UL listed and/or CSA certified.

C. Blower motor(s) and compressor(s) shall be UL listed and/or CSA certified.

D. All refrigerant pipes shall be copper type "L" and Eco-Guard coated for corrosion prevention.

E. Units shall be completely factory assembled, wired, piped and tested. All controls shall be factory adjusted and pre-set to the design conditions. Test report shall be available on request. Engineer reserves the right to witness factory performance testing. Units not factory tested and without test report shall not be acceptable.

F. Manufacturer of the packaged system for natatorium environmental control shall have a minimum of 25 years experience in the production of these systems and have at least 5 similar or larger units in operation.

G. The system shall have a limited warranty for twenty-five months from shipment.

H. The entire cabinet shall be painted internally and externally.

1.3. BASIS OF DESIGN

A. Unit shall be base bid with specified Dectron Inc. (Dry-O-Tron ®) with capacities as scheduled.

B. An Add or Deduct Alternate (substitution) may be provided as indicated on the bid form subject to the following conditions:
1. Substitution shall include revised layout including details on duct, piping, and power connections.
2. Substitution shall include full disclosure (by paragraph and schedule) to be submitted with the bid. Full disclosure shall clearly list and define any exceptions or deviations to the specified equipment and performance.
3. Increased operating costs due to larger blower motors, compressors and water pumps shall be highlighted as part of the disclosure package.
4. A written guarantee shall be provided by the alternate manufacturer that the alternate product meets or exceeds the operational performance and respects the principles and priorities of the design.

1.4 SUBMITTALS

A. Submittal package shall include: performance and technical data, dimension drawing, field wiring, operating sequence, general unit specifications, corrosion coating specifications, microprocessor controls specifications, accessories specifications, general system design requirements, service access requirements and warranty.

B. Basis of unit selection and performance with supporting documentation to be furnished with bid. Guaranteed maximum annual operating cost to be supplied with bid.

C. A copy of a similarly sized unit's actual quality control and testing report to be submitted for the engineers' review.

1.5 OPERATING AND MAINTENANCE DATA

A. Electrical wiring diagrams, installation and maintenance instructions and an owner's manual shall be supplied with each unit.

PART 2 – PRODUCTS

2.1 GENERAL

A. The dehumidifiers shall be single package units. Each unit shall include compressor(s), evaporator (dehumidifying coil), condenser (air reheat coil), supply air blower(s), blower motor(s), motor starters and controls in one complete enclosure. All controls shall be via fully programmable and fully self-diagnostic microprocessor.

B. The unit shall be designed for indoor installation.

C. Entire unit shall be ETL listed and/or CSA certified. Units with listed components only shall not be acceptable.

D. Unit shall be supplied with integral space heating coil sized to meet the skin losses and outdoor air heating loads.

2.2 PRINCIPLE OF OPERATION

A. The unit shall be designed to maintain optimum comfort levels.

B. The unit shall operate according to the following sequence. The warm humid air from the natatorium passes through the dehumidifying coil and is cooled below its dew point, thereby condensing moisture. The heat captured by this process and the heat generated by the compressor power consumption are absorbed by a mechanical refrigeration system. This heat is then distributed as specified herein.

C. All heat shall be transferred to the air and contribute to the pool enclosure heating requirement unless air conditioning is in operation. The leaving supply air dry bulb temperature is always the same or higher than the entering return air temperature,except when air conditioning is in operation.

2.3 CABINET

A. The base shall be constructed of 14-gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint-ready satin coat finish. Cold rolled steel shall not be acceptable. The metal shall be formed and reinforced for maximum rigidity. The entire base shall be phosphate degreased and painted with baked epoxy powder paint,providing a chlorine and pool chemistry resistant finish.The cabinet shall be constructed of 14-gauge hot dipped zinc coated sheet metal. The zinc coating shall be smoothed to a paint-ready satin coat finish. Entire cabinet shall be painted internally and externally. All metal to be phosphate degreased and then painted with a 3 mils baked polyester powder paint, providing a 1000 hr + salt spray resistant finish, color White. Partitions and walls shall have minimum 1/2-inch deep corner bends for structural rigidity.

B. All doors and service panels shall provide access to all internal parts from both sides and in both sections.

C. Each unit shall have a built-in electrical control panel in a separate compartment in order not to disturb the air flow within the dehumidifier during electrical servicing. All electrical components shall be mounted on a 14-gauge painted sub-panel. Direct mounting of components to the partition wall shall not

be acceptable. Control panel shall be under negative pressure to not allow any pool air from entering during blower operation.

D. The unit shall have a built-in air filter rack with separate hinged access door with compression fasteners. The filter rack shall be minimum 12'' deep.The unit shall be equipped with an opening suitable for connection of a duct to admit outdoor air to comply with ASHRAE Ventilation Standard 62-1999. Outdoor air intake assembly shall be welded to become an integral part of the enclosure. The section shall be painted internally and externally. It shall have a built-in air filter rack with separate hinged access door and (motorized damper controlled by seven-day time clock). Outdoor air shall be admitted between the evaporator and condenser coils.All components not requiring welding shall use ¼'' plated steel bolts fastened to permanently enclosure mounted nuts. Loose bolts and sheet metal screws shall not be acceptable.

2.4 INSULATION

A. The unit shall be insulated with 1/2-inch thick, fiberglass duct liner insulation, approved for 250°F operating temperature and up to 5,000-fpm air velocity.

B. Surface to be protected against perforation with a reinforcing mesh. Fire resistance rating to conform to NFPA Standard 90A. Sound attenuation coefficient shall be not less than 1.06 at a frequency of 1000 Hz as per ASTM Standard C423. Thermal conductivity shall be not more than 0.232 Btu·in./h·sq. ft.·F at 75°F. Insulation shall be securely fastened by spot welding to become an integral component of the enclosure and held on by mechanical fasteners. Adhesives shall not be acceptable. The unit panels shall have minimum "R" value of 2.2.

2.5 EVAPORATOR (DEHUMIDIFIER COIL)

A. Shall be six or eight rows deep for maximum moisture removal capacity with air velocity not to exceed 500 fpm, with 3/8-inch OD seamless copper riffle tubing mechanically expanded to assure high heat transfer with maximum ten aluminum fins per inch. Coils over 45-inches high shall have an intermediate one piece drain pan constructed of 20-gauge hot dipped zinc coated corrosion resistant sheet metal and painted after fabrication with a USDA-approved converted epoxy resin providing a chlorine and pool chemistry resistant finish.

B. Shall be HyPoxy® coated fins for maximum corrosion resistance. Untreated fin material shall not be acceptable. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.

C. Coil shall have a 16-gauge galvanized casing and end plates.

D. An adjustable damper shall be installed above the evaporator coil for apparatus dew point control during cold water start-up. Capacity reduction methods shall absolutely not be used for dew point control. Systems with variable outdoor and return air flows shall have automatic air flow correction via motorized bypass dampers. Coils without bypass air shall not be acceptable.

E. Coil shall be factory tested at air pressures not less than 400 psig in a water bath

2.6 CONDENSER (AIR REHEAT COIL)

A. Shall be sized to transfer 100% of the compressor heat of rejection into the air if necessary with 3/8 inch OD seamless copper tubing mechanically expanded to assure high heat transfer with maximum twelve aluminum fins per inch.

B. Shall be HyPoxy® coated fins for maximum corrosion resistance. Untreated fin material shall not be acceptable. Coating shall comply with ASTM B117/D1654 and ASTM D2126 for corrosion resistance.

C. Coil shall have a 16-gauge galvanized casing and end plates.

D. Coil shall be factory tested at air pressures not less than 600 psig in a water bath.

2.7 DRAIN PAN

A. Each unit shall be equipped with a sloped non-trapping drain pan under the entire evaporator coil and prevent condensate carryover. Flat drain pans susceptible to water pooling and subsequent bacteria growth shall not be acceptable.

B. The drain pan shall be made of 12-gauge gray Noryl resin with hair cell finish, temperature resistant to 200 °F complete with sanitary round corners and unit mounted 1 1/2 inch P-trap with side drain connection.2.8

2.8 BLOWER

A. Blower(s)
1. Shall be high performance direct drive radial fan with centrifugal backward-curved impeller. The fan unit shall be epoxy coated.
2. The inlet cone shall be made of epoxy coated steel. The inlet cone is optimized to give the best possible aerodynamic performance and high efficiency.
3. The single inlet impeller shall have backward curved airfoil blades made of epoxy coated steel. The impeller is statically and dynamically balanced according to quality level of G2.5 (ATE G=6.3) and in accordance with DIN ISO 1940-1. The impeller is secured to the shaft through a hub.

B. Blower Motor(s)
1. Shall have inverter-rated insulation system and be open drip-proof, Class F insulation, induction type and pre-lubricated ball bearings. Motors shall have a service factor rating of 1.15 or higher and must be marked premium efficiency.

C. Blower Direct Drive Assembly
1. All impellers are statically and dynamically balanced to a grade of G= 2,5 in accordance with DIN ISO 1940-1. The impellers are secured to the shaft through a steel hub.

2.9 VFD DRIVE PACKAGE:

A. The variable frequency drive shall be specifically designed for HVAC fan motors.

B. The variable frequency drive(s) Control Panel(s) is located out of air stream.

2.10 COMPRESSOR(S) R-410A

A. Units shall have hermetic or scroll compressor(s), suction gas cooled, suitable for refrigerant R-410a, equipped with internal solid state sensor thermal protection, service valves, resilient type external mounting and easily removable external crankcase heater for liquid migration protection.

B. Compressor manufacturer must have a wholesale outlet for replacement parts in the nearest major city.

C. Shall be located in a compartment out of air stream in order not to disturb the air flow within the dehumidifier during servicing.

D. Compressor(s) shall have a 3-year extended warranty underwritten by the manufacturer. Third party coverage shall not be acceptable.

2.11 REFRIGERATION CIRCUIT R-410A

A. Shall have an in-line solder type liquid line filter drier, liquid and moisture indicator visible from outside the unit without removal of the access panel, and thermostatic expansion valve.

B. Tamper proof, hermetically sealed non-adjustable high and low pressure controls and refrigeration service valves shall be installed using Schraeder type valves.

C. Refrigeration service valves shall be located outside of the air stream.

D. Suction line shall be fully insulated with not less than ½-inch closed cell insulation.

2.12 CONTROL PANEL

A. Shall be built-in within a separate compartment in order not to disturb the air flow during servicing.

B. All electrical components shall be mounted on a 14-gauge painted sub-panel. Direct mounting of components to the partition wall shall not be acceptable.

C. Blower motor(s) and compressor(s) shall be controlled by contactors.

D. Blower motor(s) and compressor(s) shall be thermally protected.

E. Voltage monitor shall be provided to shut down electrical system to prevent damage in the event of temporary voltage fluctuation, phase loss, or phase-sequence reversal. Voltage monitor shall be auto reset.

F. Unit shall be provided with single point power connection. Dual power connections shall not be acceptable.

G. Dry contacts shall be provided for auxiliary pool heater, alarm and blower interlock.

H. Color coding and wire numbering shall be provided for easy troubleshooting. All wires shall be in a wire duct.

I Compressor(s) shall have a time delay start to prevent short cycling.

J. All wiring shall be installed in accordance with UL and/or CSA safety electrical standards, and shall be in accordance with NFPA 70 - National Electrical Code in the USA and/or CEC - Canadian Electrical Code in Canada. All components used shall be UL Listed or Recognized and/or CSA Certified.

K Electrical contractor shall be responsible for external power wiring, disconnect switch and disconnect switch fusing.

L. Programmable seven-day time clock with dry contacts for mode status

2.13 MICROPROCESSOR CONTROL - SUPERVISAIRE®

A. Unit shall be monitored and controlled with a solid state microprocessor system complete with control panel equipped with an integrated 4-line by 20 character backlit LCD display and keypad.

B. Programmable thermostats and electromechanical controls shall not be acceptable.

C. The following status and alarm functions shall be displayed on the operator panel and monitored by the controller when required:

2.14 STATUS MESSAGES:

Blower remote switch off	
Blower turned off	
Compressor 1 emergency switch off	
Compressor 1 turned off	

Manual reset required	
Blower on	
Compressor 1 pump down	
Please wait…compressor 1 will auto reset (high pressure, low pressure, overheat)	
A.S.C.T. 1 on	
Dehumidification on	
A/C on	
Oil return mode 1 on	
Aux. air heating on (stage 1, stage 2)	
Evaporator damper closed	
Pool 1 heating on	
Pool 1 aux. On	
Pool 1 heating call	
Dehumidification call	
Air heating call	
Cooling call	
Occupied period	

2.16 ALARM MESSAGES:

Expansion module communication failure	
Humidity sensor fault	
Return air sensor fault	
Supply air sensor fault	
Evaporator 1 sensor fault	

Pool 1 in sensor fault	
Pool 1 out sensor fault	
Pool 1 leaving water too hot	
Pool 1 low water fault	
Pool 1 performance alarm	
Discharge 1 sensor fault	
Power failure	
Blower overload	
Compressor 1 high pressure fault	
Compressor 1 low pressure fault	
Compressor 1 overheat	
Compressor 1 overload	
Compressor 1 high discharge fault	
Compressor 1 low discharge fault	
Compressor 1 pump down too long	
Firestat alarm	
Air heating performance alarm	
Cooling performance alarm	

A. The following sensors shall be factory mounted in the unit. Field mounted sensors shall not be acceptable. The sensor data shall be displayed on the operator panel and monitored by the controller as required:

Return air temperature	
Supply air temperature	
Air off evaporator 1 temperature	
Return air relative humidity	
Compressor 1 hot gas temperature	
Entering pool 1 water temperature	
Leaving pool 1 water temperature	

A. All sensors shall be factory tested and calibrated. Easy-to-use field calibration capability shall be provided through the operator panel. Humidity sensor shall be corrosion resistant, especially suited for harsh exposure such as indoor pools and spas with chlorine containing environments.

B. The control program shall be factory developed to user specification, factory tested and loaded into the controller. Through the operator panel, the user shall be able to set/perform the following functions:
   1. Compressor 1 auto/off mode
   2. Blower auto/off mode
   3. Manual reset
   4. Change all humidity and temperature set points
   5. Program 7-day timer schedule for occupied period (there shall be 3 on/off periods for each day of the week)
   6. Disable or force occupied period
   7. Service mode (password protected) for:
      a. Heating / cooling deadband and differential
      b. Sensor calibration
      c. Minimum damper setting
      d. Evaporator damper setting
      e. Compressor run time

A. The following features shall be preprogrammed and used when required:

1. Auto reset 3 times
   a. High pressure, low pressure and compressor overheat faults shall automatically reset after the compressor has stopped for 5 minutes. A message shall be displayed at the operator indicating the reason. If the fault repeats 3 times, the compressor shall lock out on alarm.
2. Timed pump down
   a. If pump down continues longer than the allotted time, the compressor shall stop.

3. Performance monitoring
   a. The unit shall evaluate its own performance. If it is not satisfactory, an alarm shall be triggered and the fault shall be displayed at the operator panel.

4. Oil return mode
   a. Unit shall recover migrated oil by operating in air conditioning mode at timed intervals.

5. Ventilation in case of compressor failure (selectable)
   a. Ventilation shall be selectable to operate for cooling and / or dehumidification in case of compressor failure.

6. Staged air heating with integral time
   a. Auxiliary air heating stages shall automatically ramp up by an integral time if the current stage level does not satisfy the demand.

7. Compressor discharge temperature monitoring
   a. The microprocessor shall monitor compressor hot gas temperature in order to protect the compressor from high and low superheat.

8. Built-in troubleshooting guide
   a. There shall be a built-in troubleshooting guide accessible through the operator panel.

9. Alarm logging
   a. Last 100 alarms are saved with a snapshot of the conditions at the time the alarm occurred. Can be viewed via the OP or downloaded to a factory EPROM. English/French selectable via operator panel in selectable options menu.

B. The programmable controller shall consist of:

1. PROGRAM MEMORY: 1MByte of Flash Memory

2. POWER CONSUMPTION: 20W

3. POWER SUPPLY: 24 Vac ± 15% 50/60Hz or 22-40 Vdc

4. OPERATING CONDITIONS:
   a. temperature: 14 - 140°F
   b. humidity: less than 90%, non-condensing

5. STORAGE CONDITIONS:
   a. temperature: -4 - 158°F
   b. humidity: less than 90%, non-condensing

6. ANALOG INPUTS:
   a. 4 analog inputs, selectable between NTC, PT1000, ON/OFF
   b 6 analog inputs, selectable between NTC, 0-1V, 0-10V, 0-20mA, 4-20mA

7. ANALOG OUTPUTS: 6 optically-isolated 0-10V analog outputs

8. DIGITAL OUTPUTS: 18 digital relay outputs (5 of which with switching contacts)

9. INDEX OF PROTECTION: general: IP20

10. OPTIONS:

11. BACnet protocol / MSTP

2.16 RETURN AIR FILTERS

A. The first set of Return Air Filters shall be a set of two (2) inch Extended Surface, Pleated Filters with Antimicrobial MERV 8 rating (ASHRAE 52.2), suitable for commercial applications where 30-35% dust spot efficiency is desired or required. It is also suited to high moisture conditions where bacterial growth may be likely to occur on air filters. The antimicrobial treated media used minimizes the chance of bacterial growth. Initial resistance of **0.33** in.W.G based on **500** FPM air velocity.

2.17 OUTDOOR AIR CONNECTION

A. Filters shall be two-inch cleanable type air filters suitable for commercial application. The filtering element shall be made from 100% virgin natural fibers, spun into a high loft, interlocking maze. The fibers shall be bonded to tough scrim backing for rigidity. The frame shall be made of galvanized, formed channel with drain holes punched for ease of cleaning. The frame shall enclose a 16-gauge wire air leaving grid and 10-gauge wire front support grid for maximum filter pad support. Initial resistance at 100% R.A.F. of 0.07-inch W.G., dust holding capacity of 232 grams/ft2 and average arrestance efficiency of 67% based on 500 fpm air velocity.

B. Motorized balancing dampers shall be opposed type with overlapping blade and double seals to minimize leakage. Damper leakage shall be less than 0.4% of maximum flow at 10-inch W.C. differential. Damper blades shall be mounted on steel rods which rotate on nylon bushings. Damper blades shall be extruded aluminum. All damper hardware shall be corrosion resistant.

2.18 AIR-COOLED AIR CONDITIONING

A. Unit shall be equipped with air conditioning feature to reject all compressor heat to a Remote (Split) outdoor air-cooled condenser. The outdoor condenser shall be equipped with transformer and 24VAC control including contactor for fan motor.

B. Unit shall be provided with a dry contact rated for 24VAC/5A to operate the remote outdoor condenser control.

C. Refrigeration circuit shall include three way refrigerant valve, receiver with pressure relief valve (valve vented outside cabinet if refrigerant charge over 100 lbs) set at 400 psig (600 psig for R410A) sized to hold the outdoor condenser charge, pressure control and pressure differential valve(s), and two shutoff valves to isolate the outdoor condenser.

D. Unit shall include an oil separator package if circuit system charge is over 200 lb or line length is over 75 feet.

E. Hot gas lines shall be fully insulated with not less than 3/8-inch closed cell insulation. Units without insulated hot gas lines in the air stream shall not be acceptable.

2.19 ELECTRIC HEATER [SPACE AND/OR OA]

A. Electric heater shall be factory installed.

B. Frame shall be galvanized cold rolled steel sheet, minimum 20-gauge including a protective screen. Heating elements shall be nickel-chromium resistance wire elements, supported on ceramic bushings held in element support brackets. Elements shall be crimped to monel or stainless steel terminal lugs and terminal lugs and terminal pins shall be positively prevented from corroding by means of non-round bulkhead bushings including protective screens.

C. Built-in controls shall be supplied with electric heater as integral and prewired components, contactors, fused control transformer, pressure differential switch, power supply terminals, control terminals, thermal overheat protection.

D. Electrical contractor shall be responsible for external power wiring, disconnect switch and fusing.

E. Electric heater shall be supplied with a SCR control.

F. Single point power connection.

PART 3 - EXECUTION

3.1 MANUFACTURER:

A. Specified manufacturer shall be Dectron, Dry-O-Tron® Model DV5-040 Conventional Energy Recycling Natatorium Environmental Control System, no equal with capacities as scheduled.

B. Alternate Bid shall include revised layout including details on supply / return air connections, piping connections, ventilation / exhaust connections, power / control wiring connections. OEM's unit selection printout using above design criteria, all fan curves clearly showing HP, BHP, ESP, TSP and Sound Power Levels per fan. OEM Certified System Energy Analysis comparing to a Variable Volume Make Up Air System.

C. Alternate Bid shall include full disclosure (by paragraph and schedule) to be submitted to the engineer ten days prior to the bid and approved by the engineer in writing prior to the Bid. Full disclosure shall clearly list and define any exceptions or deviations to the specified equipment and specified performance and any items that exceed the specifications.

D. Where the intent of the specification is met but with different construction materials or methods the difference shall be completely defined by paragraph in the full disclosure. The full disclosure shall include an OEM's unit selection printout using above design criteria, all fan curves clearly showing HP, BHP, ESP, TSP and Sound Power Levels per fan. OEM Certified System Energy Analysis comparing a Variable

Volume Make Up Air System.

E. As an Alternate, bidder shall state a separate extended guarantee covering the 2nd and 3rd year of operation. This guarantee shall include all costs of labour, materials and supplies required to correct such defects or resulting from such defects.

3.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle unit carefully to prevent damage, breaking, denting and scoring. Damaged units or damaged components shall not be installed. Replace all damaged parts with new parts from the manufacturer.

B. If unit is to be stored prior to installation, store in a clean, dry place. Protect from weather, dirt, fumes, water, construction and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading the unit and moving it to the final location.

3.3 INSTALLATION

A. Execute the work in accordance with the specifications and in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

B. Avoid interference with structure and the work of other trades; do not cut into load carrying members without the specific approval of the Architect/Engineer.

C. Inspection: Check each piece of equipment in the system for defects, verifying that all parts are properly furnished and installed, that all items function properly, and that all adjustments have been made.

D. Small rooftop or condensing units not curb supported shall be supported in a manner that protects the roofing system, using prefab supports equal to heavy duty Pipe Pier system, using multiple units connected with Eristrut channel.

E. Unit(s) shall not be run at any time during any construction phase. A request can be made but Manufacturer reserves the right to refuse the request. Otherwise, unit(s) standard two (2) year and all extended warranties will be voided.

F. After Pre Start-Up Verification. Air Balancing Must be completed before SU date and report sent to Dectron. [Air Balancing By Others]. Project SU: co-ordinate with Dectron Local Representative & Service.

3.4 WARRANTY

A. A twenty-five month parts warranty on the entire unit.

B. An extended 3 years of parts coverage on the compressor.

C. These warranties are contingent on proper maintenance of pool water chemistry. Refer to Owner's Manual for proper pool water chemistry parameters. These parameters are to be measured and recorded daily and be available for review upon request.

3.6 RECOMMENDED FIRST YEAR PREVENTATIVE MAINTENANCE

A. A specialized dehumidification system has been designed for this natatorium to provide for the longevity of the facility protecting it against the damages of condensation which would otherwise occur. This dehumidification system also provides for occupant comfort as a primary consideration. It is the intention that through this preventative maintenance and service program the owner shall be assured that the dehumidification system operates at its optimum.

B. The maintenance contractor shall provide a separate price to provide labor, equipment and tools necessary

to keep the listed equipment in operating condition. This shall include at a minimum twelve (12) regularly scheduled preventative maintenance visits per year. Labor to be performed during normal working hours in the presence of the Owner representative. Provide a one year maintenance contract.

C. The contractor shall provide as necessary routine and/or unscheduled service to diagnose and repair the dehumidifying equipment during normal working hours. These visits shall be scheduled and coordinated with the Owner to ensure that Owner representative is present.

D. Qualifications
   1. The contractor shall be a licensed class A or B Contractor in the State with one or more of the technicians regularly working on this equipment holding a Master Mechanics License.
   2. Contractor must be certified to work on Dectron Equipment and have a valid up to date certification card. **[**Call 1-888-DECTRON ask for Service]

END OF SECTION 23 8416

END OF DIVISION 23