## 1 GENERAL

### 1.1 SECTION INCLUDES

1.1.1 Optimair® Indoor and Outdoor Air Handling Units

1.1.2 References

| | | |
|---|---|---|
| 1.1.2.1 | AFBMA 9 | Load Ratings and Fatigue Life for Ball Bearings |
| 1.1.2.2 | AMCA 99 | Standards Handbook |
| 1.1.2.3 | AMCA210 | Laboratory Methods of Testing Fans for Rating Purposes |
| 1.1.2.4 | AMCA 300 | Test Code for Sound Rating Air Moving Devices |
| 1.1.2.5 | AMCA 500 | Test Methods for Louvers, Dampers, and Shutters |
| 1.1.2.6 | ARI 410 | Forced-Circulation Air-Cooling and Air-Heating Coils |
| 1.1.2.7 | NEMA MG1 | Motors and Generators |
| 1.1.2.8 | NFPA 70 | National Fire Protection Code |
| 1.1.2.9 | SMACNA | HVAC Duct Construction Standards – Metal and Flexible |
| 1.1.2.10 | UL 900 | Test Performance of Air Filter Units |
| 1.1.2.11 | ASHRAE 62-89 | Ventilation for Acceptable Indoor Air Quality |

### 1.2 SCOPE

1.2.1 Provide air-handling units designed and manufactured to the specific requirements of this project.

### 1.3 QUALITY ASSURANCE

1.3.1 The units shall be supplied by a recognized manufacturer whose manufacturing process is ISO 9001:2000 certified.

1.3.2 Local service shall be available either directly from the factory or through the local certified factory representatives.

1.3.3 Major components shall be products of recognized manufacturers regularly engaged in production of such equipment and whose products are in compliance with industry standards.

1.3.4 The following parameters shall establish the selection criteria and shall be as specified: airflow rates, external static pressures, and water flow rates. The following are to be as specified or improved: coil and filter face velocities, cabinet air leakage rate, inlet/discharge/radiated sound power levels, and internal static pressures/brake horsepower.

1.3.5 Unit manufacturer shall provide tests to verify CASING AIR LEAKAGE. Casing leakage tests shall verify that unit casing leakage is less than 1 % of design airflow at 1.25 times the design static pressure or 1.1 times the fans peak static pressure at design RPM's. **Positive Pressure Side Test** : Duct openings in positive pressure section shall be sealed. This section shall be connected to a fan developing 1.25 times design positive static pressure. The air leakage volume shall be obtained using a calibrated orifice plate device. This CFM shall be considered casing leakage. **Negative Pressure Side Test** : Duct openings in negative pressure section shall be sealed. This section shall be connected to a fan developing 1.25 times design negative static pressure. The air leakage volume shall be obtained using a calibrated orifice plate device. This CFM shall be considered casing leakage. Casing leakage must be less than 1 % of unit design airflow. The manufacturer's quality control manager shall sign the report. Air handlers with oversized cabinets (low face velocities), and units with very low air volumes, require special consideration. Please contact the factory for developing cabinet air leakage specifications with exceptional performance characteristics.

1.3.6 Units shall be factory built and shipped in a single piece or multiple sections depending on the project specification and/or field restrictions.

1.3.7 Fans shall conform to AMCA standards regarding testing and construction. Fans shall bear the AMCA certified rating seal for sound and airflow.

1.3.8 Heating and cooling coils shall be ARI certified.

1.3.9 Filter media shall be ULC listed.

## 1.4 OPERATION AND MAINTENANCE DATA

1.4.1 Include instructions for lubrication, filter replacement, motor and drive adjustment and replacement, spare parts lists, and wiring diagrams.

## 1.5 DELIVERY, STORAGE AND HANDLING

1.5.1 Accept products on site in factory applied protective wrapping, and factory installed lifting lugs. Inspect for damage. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

## 1.6 ENVIRONMENTAL REQUIREMENTS

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

## 1.7 APPROVED MANUFACTURERS

1.7.1 Companies specializing in manufacturing the products specified in this section with a minimum of ten (10) years documented experience, and issuing complete catalog data on total product.

1.7.2 The following manufacturers are approved subject to meeting the specification in its entirety:

1.7.2.1 Racan Carrier
1.7.2.2
1.7.2.3

1.7.3 The following manufacturers are approved to bid as an alternate manufacturer, subject to meeting the specification in its entirety and showing cost savings to the base bid:

1.7.3.1
1.7.3.2
1.7.3.3

## 1.8 SUBMITTALS

1.8.1 Submit shop drawings and product data.

1.8.2 Shop drawings shall be clear and legible with an index format to identify different sections. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable, and submission date, leaving adequate space for approval stamps.

1.8.3 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the specification. It is the responsibility of the supplier to highlight any variances his equipment has with the requirements of this specification.

1.8.4 Shop drawings shall include appropriately scaled CAD drawings. Drawing files shall be available electronically or on disk.

1.8.5 Product data shall include dimensions, weights, capacities, component performances, electrical characteristics, construction details, required clearances, field connection details, proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.

1.8.6 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

1.8.7 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.

1.8.8 Provide details showing condensate drain connection height and required P-trap height.

1.8.9 Provide filter information, including initial APD, final APD, dust spot efficiency, final dust holding capacity, filter media description, filter frame details, filter replacement details, and filter gauge details if applicable.

1.8.10 Submit air handling unit inlet, discharge, and radiated sound power levels at nominal capacity.

1.8.11 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

1.8.12 Submit manufacturer's recommended installation instructions.

1.8.13 Omission of any of the above information will cause submittal package to be immediately returned without review.

## 2 PRODUCTS

2.0 Provide factory assembled air handling unit in configuration as indicated on drawings. Unit shall include all specified components installed at the factory (unless otherwise specified). Field fabrication of units and their components will not be acceptable. Prior to shipment, the units will be available to the customer for a final inspection.

### 2.1 4" CASING – SIDE AND ROOF PANEL CONSTRUCTION

2.1.1 All side and roof panels shall be constructed of minimum 4" (100 mm) thick double wall thermal acoustic panels. They shall have a 4" thick cross-section and filled with 4" thick fiberglass insulation. The insulation shall have a thermal resistance equivalent to R-4 per inch. The wall liners shall individually cover each panel to provide a sturdy and uniform insulation protection. If required, the panels shall be internally reinforced with galvanized steel Z channel stiffeners for structural integrity and to prevent air induced internal vibrations.

2.1.1.1 Exterior wall panels shall be a minimum of 16-gauge G-90 galvanized steel. The inner wall shall be a minimum of 22-gauge solid G-90 galvanized steel.

2.1.1.2 All panels shall be internally fastened together with intermediate adjoining T-mullions and externally sealed with a heavy bead of polyurethane caulking compound to provide a visible assurance of seal. Units must be suitable for pressure differentials up to 10" w.g. static pressure.

2.1.1.3 The insulation media shall have long resilient inorganic glass fibers bonded with a thermosetting resin.

2.1.2 Tedlar film shall completely wrap around the insulation to protect it and prevent fiber erosion. Neoprene coated insulation is not acceptable due to its potential for fiber erosion and bacterial growth, nor is foil faced insulation due to its easy tearing characteristics.

2.1.3 Outdoor units' roof panels shall utilize standing seam construction with cap strips over roof flanges. Cap strips shall be turned down on both sides and shall include slimmed profiles to allow water runoff. The roof shall be sloped a minimum of ¼ in./ft. to ensure rain and snow runoff. Roof system shall be designed for 30-lbs./ft.$^2$ snow load.

2.1.4 Outdoor units' exterior surface shall be painted with a high quality air-dried waterborne polyurethane copolymer.

2.1.4.1 The entire exterior surface shall be thoroughly degreased. A 1-mil thick epoxy based primer shall be applied with one 3-mil finishing coat of waterborne polyurethane copolymer. Paint system shall offer excellent color retention, low fade characteristics, excellent UV resistance, very good resistance to solvents, chemical fumes, and very good abrasion resistance.

2.1.4.2 Dry film characteristics:
2.1.4.2.1 Humidity: ASTM D-2447 96 hrs and 24 hrs after recovery with ASTM D-3359 adhesion method A: 5/5
2.1.4.2.2 Salt spray resistance: ASTM D-1654 1000 hrs excellent adhesion
2.1.4.2.3 Flexibility: ASTM D-1737 @ 70$^o$F – 160 in./lbs. @ -50$^o$F – 100 in./lbs
2.1.4.2.4 Pencil hardness: ASTM 3363 F to H
2.1.4.2.5 QUV: SAE J1940 Xenon weatherometer 1000 hrs 65% gloss retention

2.1.5 An independent laboratory shall have tested the acoustic performance of the panels per ASTM C423-90a and E795-93. The sound attenuation characteristics for panels with 22-gauge perforated liners shall be the following:

**OPTIMAIR® 4" WALL PANEL**

| Octave band | 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|
| Absorption coefficient | .63 | .99 | 1.16 | 1.06 | 1.07 | 1.01 |
| Transmission loss (dB) | 27 | 29 | 39 | 49 | 56 | 62 |

2.1.6 The average thermal conductance shall not exceed 0.066 BTU/sq. ft. / HR / $^o$F.

## 2.2 BASE CONSTRUCTION

2.2.1 Units shall be constructed from heavy gauge formed galvanized steel around the perimeter of each module, with intermediate formed galvanized channels spaced at no greater than 21” intervals. The minimum base height shall be 6 3/8".

2.2.2 To minimize thermal conductivity and prevent condensation, the entire perimeter frame cavity shall be uniformly insulated.

2.2.3 A 16-gauge galvanized steel floor surface shall be installed on the base and structural support grid. The floor shall be reinforced from below. All seams shall be sealed to form a watertight assembly. Base shall be provided with lifting lugs, a minimum of four (4) per unit section. The base shall be insulated with 4" (100 mm) fiberglass insulation and underlined with a 22-gauge galvanized steel liner.

2.2.4 All duct connections or control dampers in the floor of the unit shall be covered with painted heavy gauge steel bar grating bolted in place, to prevent people and large objects from passing through the unit floor into the ductwork. Bar grating shall be designed for a maximum deflection of ¼" under a concentrated load of 300 lbs. at mid span.

2.2.5 Provide auxiliary drains in fan sections downstream of cooling coils and humidifiers, economizer fresh air intakes, and in mixing boxes.

2.2.6 All drain connections on floor mounted air handling units shall terminate at the side of the unit.

2.2.7 Roof curbs shall be built in sections and bolted in the field. Curbs shall be constructed from heavy gauge galvanized steel. Nailer strips, gasketing, insulation, and counter-flashing shall be provided by the contractor and installed by the contractor.

## 2.3 2" CASING – SIDE AND ROOF PANEL CONSTRUCTION

2.3.1 All side and roof panels shall be constructed of minimum 2" (50 mm) thick double wall thermal acoustic panels. They shall have a 2" thick cross-section and filled with 2" thick fiberglass insulation. The insulation shall have a thermal resistance equivalent to R-4 per inch. The wall liners shall individually cover each panel to provide a sturdy and uniform insulation protection. If required, the panels shall be internally reinforced with galvanized steel Z channel stiffeners for structural integrity and to prevent air induced internal vibrations.

2.3.1.1 Exterior wall panels shall be a minimum of 18-gauge G-90 galvanized steel. The inner wall shall be a minimum of 22-gauge solid G-90 galvanized steel.

2.3.1.2 All panels shall be internally fastened together with intermediate adjoining T-mullions and externally sealed with a heavy bead of polyurethane caulking compound to provide a visible assurance of seal. Units must be suitable for pressure differentials up to 8" w.g. static pressure.

2.3.1.3 The insulation media shall have long resilient inorganic glass fibers bonded with a thermosetting resin.

2.3.2 Tedlar film shall completely wrap around the insulation to protect it and prevent fiber erosion. Neoprene coated insulation is not acceptable due to its potential for fiber erosion and bacterial growth, nor is foil faced insulation due to its easy tearing characteristics.

2.3.3 Outdoor units' roof panels shall utilize standing seam construction with cap strips over roof flanges. Cap strips shall be turned down on both sides and shall include slimmed profiles to allow water runoff. The roof shall be sloped a minimum of ¼ in./ft. to ensure rain and snow runoff. Roof system shall be designed for 30-lbs./ft.$^2$-snow load.

2.3.4 Outdoor units' exterior surface shall be painted with a high quality air-dried waterborne polyurethane copolymer.

2.3.4.1 The entire exterior surface shall be thoroughly degreased. A 1-mil thick epoxy based primer shall be applied with one 3-mil finishing coat of waterborne polyurethane copolymer. Paint system shall offer excellent color retention, low fade characteristics, excellent UV resistance, very good resistance to solvents, chemical fumes, and very good abrasion resistance.

2.3.4.2 Dry film characteristics:

2.3.4.2.1 Humidity: ASTM D-2447 ➤ 2000 hours
2.3.4.2.2 Salt fog: ASTM B-117 minimum 2000 hours on Bondrite panel
2.3.4.2.3 Flexibility: ASTM D-1737 @ 70°F – 160 in./lbs. @ -50°F – 100 in./lbs
2.3.4.2.4 Pencil hardness: ASTM 3363 F to H
2.3.4.2.5 QUV: ASTM G-53 1000 hours QUV A bulb 90 % gloss retention 1.6 units

2.3.5 An independent laboratory shall have tested the acoustic performance of the panels per ASTM C423-90a and E795-93. The sound attenuation characteristics for panels with 22-gauge perforated liners shall be the following:

**OPTIMAIR® 2" WALL PANEL**

| Octave band | 125 | 250 | 500 | 1000 | 2000 | 4000 |
|---|---|---|---|---|---|---|
| Absorption coefficient | .20 | .51 | 1.02 | 1.03 | .97 | .90 |
| Transmission loss (dB) | 24 | 27 | 34 | 43 | 50 | 55 |

2.3.6 The average thermal conductance shall not exceed 0.13 BTU/SQ.FT./HR/°F.

## 2.4 BASE CONSTRUCTION

2.4.1 Units shall be constructed from heavy gauge formed galvanized steel around the perimeter of each module, with intermediate formed galvanized channels spaced at no greater than

21" intervals. The minimum base height shall be 4 ½" for unit sizes 4 to 52. The minimum base height shall be 6 3/8" for unit sizes 64 and up.

2.4.2 To minimize thermal conductivity and prevent condensation, the entire perimeter frame cavity shall be uniformly insulated.

2.4.3 A 16-gauge galvanized steel floor surface shall be installed on the base and structural support grid. The floor shall be reinforced from below. All seams shall be sealed to form a watertight assembly. Base shall be provided with lifting lugs, a minimum of four (4) per unit section. The base shall be insulated with 2" (50 mm) fiberglass insulation and underlined with a 22-gauge galvanized steel liner.

2.4.4 All duct connections or control dampers in the floor of the unit shall be covered with painted heavy gauge steel bar grating bolted in place, to prevent people and large objects from passing through the unit floor into the ductwork. Bar grating shall be designed for a maximum deflection of ¼" under a concentrated load of 300 lbs. at mid span.

2.4.5 Provide auxiliary drains in fan sections downstream of cooling coils and humidifiers, economizer fresh air intakes, and in mixing boxes.

2.4.6 All drain connections on floor mounted air handling units shall terminate at the side of the unit.

2.4.7 Roof curbs shall be built in sections and bolted in the field. Curbs shall be constructed from heavy gauge galvanized steel. Nailer strips, gasketing, insulation, and counter-flashing shall be provided and installed by the contractor.

## 2.5 ACCESS DOORS

2.5.1 Access doors shall be manufactured from 18-gauge galvanized steel. The doors shall be double wall construction with 18-gauge solid metal liner on the inside. The complete access door shall be uniformly insulated consistent with the wall panel construction specified herein.

2.5.2 Provide thermal inspection windows. The windows shall be made of two ¼ inch thick tempered glass panels separated by a ½ inch air space. The inspection window shall be installed in the metal door with a heavy-duty rubber-mounting frame.

2.5.3 The doorframes shall be made from 16-gauge galvanized steel with the outside of the door flush with the unit. The corners of the frame shall have a 3" radius and shall include self-gripping automotive gasketing to ensure appropriate air tightness and durability.

2.5.4 Each door shall have two (2) cast iron "Dynair®" latches operable from either side of door and a minimum of two (2) heavy-duty strap hinges. Hinges shall be made of electro-polished 10-gauge 304 stainless steel. Doors shall be removable by releasing setscrews and pushing the pins out of the hinges. Doors must open against the high-pressure side of the air handlers.

## 2.6 BLOWER SECTION

2.6.1 Fans shall be either backward inclined or airfoil as indicated in the schedules or as implied by the specified equipment.

2.6.2 Fan performance shall be based on tests conducted in accordance with AMCA® standard test code for air moving devices. All fans shall be certified to bear the AMCA® certified rating seal. The fans shall have quiet and stable operation under all conditions. The fan manufacturer shall provide sound power ratings in the eight octave bands, which shall be based on AMCA® standards. Sound power ratings shall be in decibels referenced to $10^{-12}$ watts.

2.6.3 Fans shall be dynamically balanced. An IRD or PMC analyzer shall be used to measure velocity, and the final reading shall not exceed 0.1 inch per second. The vibration level shall be recorded on the fans as proof of the final dynamic balance at the factory.

2.6.4 Fans and motors shall be mounted on all welded, structural steel, prime coated integral bases with 2" deflection spring isolators and supplied with flexible connection between the fan and the cabinet. If required, spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing. Less efficient 1" deflection isolators and rubber-in-shear isolators are not acceptable.

2.6.5 Plenum fans shall be centered within the cabinet for best aerodynamics and the wheel tips shall be at least half a wheel diameter away from the cabinet to minimize air induced vibrations and enhance airflow profile.

2.6.6 Housed centrifugal fans shall be double width and double inlet arrangement type 3. Air inlets shall be at least 0.7 of a wheel diameter away from the cabinet wall to minimize airflow resistance. Fans shall be centered within the cabinet for best aerodynamics.

2.6.7 Fans shall be constructed of low carbon steel and painted with an approved coating. Each fan shall receive a documented inspection by a qualified inspector. The inspection shall include welding, dimensions, bearings, and overall workmanship.

2.6.8 Wheel diameters and discharge areas shall be in accordance with the standard sizes adopted by AMCA®. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration and pulsation. Housings shall be constructed of heavy-gauge steel and shall be continuously welded throughout. The standard coating shall be durable and heat resistant up to 500°F. Fan shafts shall be solid and keyed to fan wheels. They should also be keyed to the sheaves for positive wheel to shaft interlock.

2.6.9 The first critical shaft speeds shall be at least 125 % (Class I and II) and 142 % (Class III) of the fan's maximum operating speed. Bearings shall be designed for heavy-duty service with a minimum L-50 life of 200,000 hours. Bearing ratings are to be based on the fans' maximum catalogued operating speed and horsepower. Pillow block bearings shall be either single row ball or double row spherical roller type. Bearing bars shall be rigidly fixed to the base (bearing supports mounted to the inlet funnel are unacceptable). Bearing supports shall consist of two or more full-length structure uprights.

2.6.10 Provide adjustable inlet vanes and linkages where indicated in the schedules. Inlet vanes are to be designed and manufactured by the fan manufacturer, and all fan performance data is to be corrected to allow for inlet vane losses. Vane and linkage bearings are to be bronze type.

2.6.11 Housed centrifugal fans installed in a blow-thru arrangement shall be supplied with a perforated diffuser plate to uniformly diffuse air in downstream plenums.

## 2.7 MOTORS AND DRIVES

2.7.1 Motors shall be supplied in accordance with electrical/mechanical specifications and schedules. They shall be mounted on slide bases for proper alignment and belt tension adjustment.

2.7.2 Provide V-belt, cast-iron sheaves, and reinforced rubber belts (minimum of 2 belts per drive). The belts and drives shall be selected for minimum 150 % of the motor nameplate horsepower. Provide adjustable motor sheaves on motors of 10 HP (7.5 kW) and less.

2.7.3 Belt drive types and service factor shall be in accordance with the general mechanical specifications.

2.7.4 Motors shall be premium efficiency, open drip-proof.

## 2.8 VIBRATION ISOLATION

2.8.1 An integral all welded structural steel vibration isolation base shall be provided for the fan and motor. Motor slide bases shall be the double adjustment type. Unpainted or galvanized, bolted together fan/motor bases are not acceptable. The base shall be free-floating on spring type isolators at all four corners.

2.8.2 Isolators shall be seismic, with leveling bolts and neoprene isolation pads, selected to a minimum efficiency of 95%.

2.8.3 Minimum spring deflection shall be 2" (50 mm).

2.9 **COILS**

2.9.1 Coils shall be fully enclosed within the section and shall have double wall galvanized floor construction consistent with the unit casing construction.

2.9.2 Piping connections shall extend to the outside through rubber grommets. Cooling coil connections shall include dual rubber grommets: on the outer skin and inner liner.

2.9.3 Coil(s) shall include galvanized steel blank off sheets to hold coil(s) rigid and prevent air from bypassing the coil(s).

2.9.4 2” thick removable access panels shall be provided on both sides to remove coils through casing wall. Coils shall be mounted on independent stainless steel racks and shall be individually removable.

2.9.5 Blow-thru double-deck sections shall be supplied with two inspection access panels, one upstream and one downstream of cooling coils.

2.9.6 Drain pans shall have a double slope for positive drainage, constructed of 16-gauge – 304 stainless steel and continuously welded. Drain pipe connections shall be 1 ½" brass sweat fittings.

2.9.7 Intermediate coils shall have double slope drain pans, constructed of 16-gauge – 304 stainless steel and continuously welded. Intermediate drain pans shall have 1" drains flowing into the main drain pan. High air volume units and/or high latent load units shall have individual drain connections for each stacked drain pan within the section.

2.9.8 Floor drain hubs shall be recessed in the pans to ensure complete drainage.

2.9.9 Coils shall be tested and rated in accordance with air conditioning and refrigeration institute (ARI) standard 410.

2.9.10 The complete coil core shall be tested with 315 pounds of air pressure under warm water and be suitable for operation at 250 psig working pressure. Water coils shall be circuited for drainability without removing individual plugs from each tube.

2.9.11 The primary surface of all coils shall be round seamless copper tubes. The secondary surface shall consist of rippled aluminum plate fins. Fins shall have full drawn collars to provide a continuous cover over the entire tube surface for maximum heat transfer. The tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire fin length.

2.9.12 Coil casings shall be constructed of galvanized steel. Coil side plates shall be of reinforced flange type construction.

2.9.13 Water coils shall have copper headers, steel male pipe connections, a vent connection at the highest point, and a drain connection at the lowest point.

2.9.14 Non-freeze steam coils shall have copper headers, steel male pipe connections, tube-within-a-tube construction, and shall be pitched in the section to ensure positive condensation drainage.

2.9.15 Refrigerant coils shall have brass liquid distributors and sweat type copper suction connections.

2.9.16 Tube material & thickness: 5/8" OD, 0.020" thick copper

2.9.17 Fin material & thickness: 0.008" aluminum

2.9.18 Coil casing material: galvanized steel

2.9.19 Coil coating including casing: none

## 2.10 INTEGRAL FACE AND BYPASS COILS

2.10.1 Furnish ARI certified VIFB steam or hot water heating coils. Each VIFB coil to bear the ARI standard 410 certification seal.

2.10.2 Each heating coil to consist of built in series of finned heating elements and bypasses with interlocked dampers controlled by optional electric damper motors and air stream thermostat. Dampers to be arranged so as to completely enclose and isolate the heating coil passes when no temperature rise is required. Each coil shall be capable of maintaining a constant discharge air temperature regardless of variations in entering air temperatures with full steam pressure or water flow at all times.

2.10.3 Proportioning of the air shall be such that the temperature at any point in a plane parallel to the face of the coil three feet downstream from the leaving side will not vary more than +/- 5 F from the average discharge air stream temperature.

2.10.4 Dampers shall be 16 gauge roll formed steel and the casing 14 gauge galvanized steel. The surfaces shall be cleaned and primed, then finished with air-dried enamel paint.

2.10.5 Finned heating elements shall be fabricated of seamless 5/8-inch O.D. return bend type copper tubes with 0.035-inch wall thickness and rectangular embossed aluminum fins of 0.010-inch thickness. Fins shall not be spaced closer than 12 fins per inch. Each tube shall be individually secured to the supply and return headers by a brazed joint with provision for individual tube expansion and contraction. Headers shall be constructed of steel tubing or pipe with a minimum wall thickness of 0.20 inches.

2.10.6 Volume of air passing through the coil shall not vary more than +/- 5%, regardless of the position of the internal dampers.

## 2.11 PRE-FILTER SECTION

2.11.1 Filter types, efficiencies and face areas shall be in accordance with the schedule.

2.11.2 Pre-filters shall be front loading where access is available upstream of the filter section or slide out through the side when access is not available. Front loading filters shall be mounted on factory fabricated 16-gauge galvanized steel holding frames complete with ¼" X ½" open cell gasket. Side access filters shall slide out through factory fabricated aluminum extrusion racks and shall have previously described access doors.

## 2.12 UPSTREAM LOADING FINAL FILTER SECTION

2.12.1 Filter types, efficiencies and face areas shall be in accordance with the schedule.

2.12.2 Filter section shall be factory fabricated as part of the air-handling unit. Filters shall be arranged for loading into positive sealing factory fabricated galvanized steel frames. Frames shall be riveted together, and the filter rack assembly mounted in the air handler. Filter rack shall include blank off sheets and thoroughly caulked to complete the seal.

2.12.3 Provide walk-in filter access sections upstream of filter rack with adequate space for filter service.

2.12.4 Where shown on the air handling unit plans, the final filter section shall include a 2” pre-filter.

## 2.13 SIDE ACCESS FINAL FILTER SECTION

2.13.1 Filter types, efficiencies and face areas shall be in accordance with the schedule

2.13.2 Filter section shall be factory fabricated as part of the air-handling unit. Extruded aluminum, side access filter rack shall accept both 2"/4" pre-filters and single header final filters. Gasketed access doors shall tightly seal filters together.

2.13.3 Provide access door on one or both sides of unit as per the drawings and specifications.

## 2.14 FILTER GAUGES

2.14.1 Provide and flush mount Dwyer 2002 Magnehelic air filter gauges.

2.14.2 Static pressure tips, shut off valves and tubing shall be provided and installed by the AHU manufacturer.

2.14.3 One Magnehelic gauge shall be provided for each filter bank.

## 2.15 MIXING BOX SECTION

2.15.1 Mixing box section shall be complete with parallel blade type dampers. They shall be positioned so that the airstreams are directed into a merging pattern. As requested, driving linkages shall be accessible from inside or outside the casing. Damper sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Where shown on plans, furnish access doors to service linkages and actuators.

## 2.16 ECONOMIZER SECTION

2.16.1 Economizer section shall be complete with parallel blade type dampers. The mixing and outside air dampers shall be positioned so that the airstreams are directed into a merging pattern. To increase the damper authority to 20% and obtain a more linear relationship between damper position and airflow, a perforated plate shall be provided at the mixing damper. As required, driving linkages shall be accessible from inside or outside the casing. Damper sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Where shown on plans, furnish access doors to service linkages and actuators.

## 2.17 AIR STRATIFICATION ELIMINATORS

2.17.1 Stratification eliminators shall have no moving or adjustable parts and shall consist of heavy gauge all welded frame containing a set of directional changing vanes and a cone designed for almost perfect mixing of air streams of different temperatures and velocities.

2.17.2 Standard construction of all welded aluminum 0.081 framing, 0.081 turbulators and aluminum directional blades.

2.17.3 Air stream temperatures shall be mixed to within $\pm 6^{o}F$ of the theoretical mixed air temperature.

2.17.4 Stratification eliminators must be selected with due and careful consideration of the required upstream and downstream distances.

## 2.18 ALUMINUM AIRFOIL DAMPERS

2.18.1 Extruded aluminum damper frame shall not be less than 0.080" (12-gauge) in thickness and 4" deep.

2.18.2 Damper blades shall be airfoil design, 6" wide and made of extruded aluminum profiles.

2.18.3 Blade gaskets shall be extruded EPDM elastomer secured in an integral slot within the aluminum extrusions. Frame seals shall be extruded TPE thermoplastic.

2.18.4 Pivot rods shall be 7/8" (22 mm) hexagon extruded aluminum interlocking into blade section. Bearings shall have a double seal with a Celcon inner bearing fixed to the rod within a polycarbonate outer bearing inserted into the frame so that the outer bearing cannot rotate.

2.18.5 Bearings shall be designed so that there is no metal-to-metal or metal-to-bearing contact.

2.18.6 Linkage hardware shall be installed outside the frame and constructed of aluminum and corrosion resistant, zinc and nickel-plated steel. Drive shaft rod shall be extendable on both sides of the dampers.

2.18.7 Dampers shall be designed for operation in temperatures ranging between –40°F (–40°C) and 212°F (100°C).

2.18.8 Damper seals shall be designed for minimum air leakage by means of overlapping seals. Air leakage through a 48" X 48" damper shall not exceed 10.3 CFM/sq. ft. against 4" w.g. differential static pressure. Air leakage data shall be certified under the AMCA certified ratings program.

2.18.9 Outdoor air damper frames shall be insulated with polystyrene on all sides and have thermally broken blades. The complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.

2.18.10 Actuators to be provided and installed by the temperature controls contractor

## 2.19 ELECTRICITY, POWER PACKAGE AND CONTROLS OPTIONS

2.19.1 Lights shall be wired to individual switches.

2.19.2 A 120V GFI service receptacle will be located beside the supply fan section door.

2.19.3 Lighting and utility receptacles shall be wired to a single 120 volt point, terminating at a designated junction box mounted on the air handling unit.

2.19.4 Motors shall be wired to individual disconnects located inside or outside their respective fan sections. Fused or non-fused disconnects shall be provided, depending on the electrical specification.

2.19.5 Motors shall be wired to variable frequency drives. The frequency drives may be provided by Racan or shipped by others to the factory for mounting.

2.19.6 Unit shall be wired with a single point power panel, including main non-fused disconnect, splitter block with individually fused power lines for each motor, a step-down 120V transformer for the lighting circuit, and a 24V transformer for control power. In this case, all wiring terminates at one main disconnect.

2.19.7 Unit shall be wired with dual point power, where the power package does not include a step down transformer for the lighting circuit. Two power points are required: one for the motors' power package and another for the lighting circuit.

2.19.8 Factory mounted temperature, humidity, pressure sensors and freeze stat. Sensors provided by controls contractor and shipped to the factory for mounting.

2.19.9 Factory mounted smoke detectors.

2.19.10 Factory installed and wired DDC control panel.

2.19.11 All components shall be CSA and/or UL approved.

2.19.12 Individual components shall be CSA or ETL factory approved for electrical safety. Approved equipment shall have a CSA or ETL label.

# 3 INSTALLATION

3.1 Use all factory provided lifting lugs to rig the units or modules. Ensure that spreader bars are used to prevent damaging the cabinets.

3.2 Lift modules in an upright position.

3.3 Ensure housekeeping pads or mounting bases are level and in accordance with approved dimensions. Air handling units or modules shall be level, shim if necessary.

3.4 Mechanical contractor shall provide and install adequately sized P-traps for all condensate pipe connections. Disposal of condensate (cooling coil, steam or floor drains) shall be in accordance with local codes.

3.5 Remove gussets, hold-down bolts and shipping fasteners.

3.6 Remove fans' shipping restraints and level spring isolators. Adjust thrust restraints.

3.7 Assemble modules together according to the installation manual.

3.8 Check fan motors for rotation and amp draw for each phase. Record information on the start-up data sheets.

3.9 Belt drives should be adjusted for tension and alignment.

3.10 Execute start-up, complete report and send to the air handling unit manufacturer for verification and as acknowledgment of warranty commencement.