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| **EDIT NOTES:**   1. **THIS SECTION REQUIRES EDITING ON A PROJECT SPECIFIC BASIS.** 2. **REVIEW CEQA REPORT AND “PRIORITY LIST OF SCHOOLS MOST AT RISK FROM AIR POLLUTION” BY OEHS, AS APPLICABLE, FOR PROJECT SPECIFIC RECOMMENDATION ON AIR FILTERS; EDIT SECTION ACCORDINGLY. EXISTING SCHOOLS WITHIN 500 FEET OF A FREEWAY REQUIRE SPECIAL FILTRATION; COORDINATE SPECIFIC REQUIREMENTS WITH DESIGN MANAGER.** 3. **WHERE THE SPECIFICATION IDENTIFIES VARIOUS TYPES OF THE SAME PRODUCT BY NUMBER, DELETE THE ITEMS NOT USED, BUT DO NOT RENUMBER THE ITEMS. RETAIN THE ORIGINAL NUMBERS OF THE ITEMS THAT ARE IN THE PROJECT. GAPS IN THE NUMBERING SYSTEM ARE EXPECTED. COORDINATE DRAWINGS WITH THE NUMBERING IN THE SPECIFICATION.** |

# **PART 1 – GENERAL**

* 1. **SUMMARY**

1. Section Includes: Air conditioning and air handling equipment including but not limited to:
2. Single Packaged Air Conditioning Units.
3. Split System Air Conditioning Units.
4. Split System Heat Pump Units.
5. Fans.
6. Related Requirements:
7. Division 01: General Requirements.
8. Section 07 60 00: Flashing and Sheet Metal.
9. Section 22 10 00: Plumbing.
10. Section 23 05 00: Common Work Results for HVAC.
11. Section 23 05 13: Basic HVAC Materials and Methods.
12. Section 23 05 48: HVAC Sound, Vibration and Seismic Control.
13. Section 23 09 00: HVAC Instrumentation and Controls.
14. Section 23 09 23: Environmental Control and Energy Management System.
15. Section 23 20 13: Above Ground HVAC Piping.
16. Section 23 20 16: Underground HVAC Piping.
17. Section 23 30 00: Air Distribution.
18. Section 23 50 00: Central Heating Equipment.
19. Section 23 64 16: Oil Lubricated Centrifugal Water Chillers.
20. Section 23 64 23: Scroll Water Chillers.
21. Section 23 64 28: Air-Cooled Rotary Screw Chillers.
22. Section 23 65 00: Cooling Towers.

**1.02 DESIGN REQUIREMENTS**

1. Work of this Section is based on HVAC equipment units indicated as Basis of Design in Part 2 of this Section. Products from different HVAC equipment manufacturers listed are never identical, although equivalent in capacity, performance and quality. In the cases where dimensions, weight, configuration and utility requirements differ from the products used as a basis of design, the Contractor, at no additional cost to the Owner, shall coordinate and submit, for Architect review, revisions to the design.

**1.03 SUBMITTALS**

1. Provide in accordance with Division 01 and Section 23 0500: Common Work Results for HVAC.
2. For products listed that are not the basis of design, submit the following in addition to above requirements:
   1. Title 24 Calculations: Replace HVAC unit values in calculation files provided by the Architect and submit for review.

**1.04 QUALITY ASSURANCE**

1. Provide submittals in accordance with Section 23 0500: Common Work Results for HVAC.

**1.05 PROJECT RECORD DOCUMENTS**

1. Provide Owner instructions on equipment operation and maintenance procedures, as indicated in Section 23 0500: Common Work Results for HVAC.

**1.06 WARRANTY**

1. Compressors shall be provided with manufacturer's five year warranty, replacement only.
2. Manufacturer shall warrant parts, except heat exchangers, for a period of five years.
3. Heat exchangers shall be provided with manufacturer’s ten year warranty, replacement only.

**PART 2 – PRODUCTS**

**2.01 EQUIPMENT**

1. Capacities of air conditioning equipment indicated on Drawings are net capacities actually required. Standard catalog ratings shall be adjusted to actual Project site environmental conditions.

**2.02 AIR CONDITIONING UNITS - AC (2 Tons-20 Tons)**

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| **EDIT NOTE: EDIT ACCEPTABLE MANUFACTURERS FROM THE LIST BELOW TO BE CONSISTENT WITH PARAGRAPH 2.02G.** |

1. Manufacturers: Carrier or Trane.

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| **EDIT NOTE: SELECT BASIS OF DESIGN FROM THE OPTIONS PRESENTED BELOW, DELETE UNUSED OPTIONS.** |

1. Basis of Design: [Carrier] [Trane]
2. Furnish packaged air conditioning unit with gas heating for roof top installation. Unit shall be self-contained, completely factory assembled, with complete internal wiring and controls. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Unit shall be field configurable for down-flow or horizontal discharge. Cooling and heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
3. Quality Assurance:
4. Units shall be CSA certified for outdoor installation.
5. Cooling capacity shall be rated in accordance with current ANSI/AHRI Standard 210/240.
6. Unit shall be UL or ETL listed and designed to conform to ANSI/ASHRAE Standard 15 Safety Code for Mechanical Refrigeration and ANSI Z21.47-2016/CSA 2.3-2016 Gas
7. ANSI/NFPA 70: National Electrical Code.
8. Unit cooling efficiency EER/SEER ratings shall comply with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
9. Unit heating efficiencies AFUE ratings shall comply with current CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings, and shall not be less than ratings indicated on drawings.
10. Unit shall comply with California Maximum Oxides of Nitrogen (NOX) Emission Regulations and current SCAQMD regulations.
11. The unit roof curbs shall conform to NRCA standards.
12. Insulation and adhesive shall meet NFPA 90A and 90B requirements for flame spread and smoke generation.
13. Unit casing shall be capable of withstanding ASTM B117 500-hour salt spray test.
14. Each unit shall be run tested at factory per ANSI/ASHRAE 37 and provided with a certificate indicating tested pressures, amperages, dates, and inspector.
15. Unit Cabinet:
16. Galvanized steel with baked enamel finish on external surfaces that are exposed to weather.
17. Interior surfaces exposed to conditioned and return air streams shall be insulated with a minimum ½-inch thick, 1 pound density foil-faced cleanable insulation.
18. Cabinet top cover shall be of one piece construction or where seams exist, shall be double hemmed and gasket sealed.
19. Cabinet panels shall be hinged access panels for filter, compressors, evaporator fan, control box and heat section areas. Each panel shall use multiple quarter-turn latches. Each major external hinged access panel shall be permanently attached to rooftop unit. Panels shall also include tiebacks.
20. Return air filters shall be accessible through a hinged access panel and be on a slide-out track using standard size filters.
21. Holes shall be provided in base rails (minimum 16 gage) for rigging shackles and level travel and movement during overhead rigging operations.
22. Unit shall have a factory-installed internally sloped condensate drain pan, providing a minimum ¾-inch-14 NPT connection to prevent standing water from accumulating. Pan shall be fabricated of high impact polycarbonate material, epoxy powder coated steel or stainless steel and shall slide out for cleaning or maintenance. An alternate vertical drain (¾-inch NPT) connection shall also be available. Drain pans shall conform to ASHRAE 62 self-draining provisions.
23. Compressors:
24. Unit shall be furnished with single (If single compressor is used, then it shall be Two Stage type) or multiple fully hermetic scroll compressors with internal vibration isolators.
25. Dual electrically and mechanically independent refrigerant circuits for 7.5 tons and above.
26. Compressors shall be provided with service access valves.
27. Compressor motors shall be cooled by refrigerant passing through motor windings.
28. Compressors shall be provided with line break thermal and current overload protection.
29. Compressors shall be provided with crankcase heaters, internal high-pressure and temperature protection.
30. Compressors on unit rated 90,000 BTU and below shall be of two stage types.
31. Refrigerant circuit components:
32. Thermostatic expansion valve (TXV) with removable power element.
33. Refrigerant strainer.
34. Service gage connections on suction, discharge, and liquid lines.
35. Solid core refrigerant filter driers.
36. Evaporator and Condenser Coils: Standard Evaporator and condenser coils shall be furnished with:

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| **EDIT NOTE: EDIT ACCEPTABLE CONDENSER COIL TYPE FROM THE LIST BELOW TO BE CONSISTENT WITH BASIS OF DESIGN EQUIPMENT SELECTION. DELETE UNUSED COIL TYPES.** |

* 1. Acceptable Condenser Coils:

1. Copper-tube, Aluminum-fin coil, with liquid subcooler. Internally enhanced OD seamless copper tubing mechanically bonded to aluminum fins in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
2. Spine Fin condenser coil shall be continuously wrapped, corrosion resistant aluminum with minimum brazed joints. This coil is 3/8 inch OD seamless aluminum tubing glued to a continuous aluminum fin. Coils are lab tested to withstand 2,000 pounds of pressure per square inch. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on four sides by louvered panels.
3. Coil shall be air-cooled Micro-Channel Heat Exchanger Technology (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide protective Hail Guard.
   1. Evaporator coils
   2. Aluminum plate fins mechanically bonded to enhanced copper tubes with joints brazed.
   3. Tube sheet openings shall be belled to prevent tube wear.
   4. Evaporator coil shall be of full-face active design.
   5. Dual circuit models shall have face-split type evaporator coil.

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| **EDIT NOTE: IF PROJECT IS LOCATED WITHIN TWO MILES FROM THE OCEAN DELETE ARTICLE G ABOVE AND EDIT PARAGRAPH 2.02A TO INCLUDE ONLY MANUFACTURERS WHICH CAN SUPPLY COPPER –TUBE, COPPER FIN COILS, AND USE PARAGRAPH BELOW.   DELETE PARAGRAPH G BELOW IF IT DOES NOT APPLY TO THE PROJECT.** |

1. Evaporator and Condenser Coils shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints with a factory applied Corrosion-Resistant Epoxy Coating utilizing dipping process. Provide protective Hail Guard.
2. Fans and Motors:
3. Direct -drive indoor fans shall be provided for the AC Units with the cooling capacity of less than or equal to 60,000 BTU/H.
4. Belt drive indoor fan shall be provided on AC Units with the cooling capacity of greater than 72,000 BTU/H include an adjustable-pitch motor pulley. Fans shall accommodate from 0.6 inch to 1.6-inch external static pressure without changing drives or motors.
5. Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged vertically. Condenser fan motor shall be ECM type motor and provide cooling operation down to 25 degrees F outdoor temperature with automatic-reset thermal overload protection.
6. Heating Section:
7. Induced draft combustion type with energy saving direct spark ignition system, redundant main gas valve, and 2-stage heat.
8. The heat exchanger shall be of tubular section type fabricated of a minimum of 20 gage steel coated with a nominal 1.2 mil aluminum-silicone alloy or 20 gage type 409 stainless steel, including stainless steel tubes, vestibule plate.
9. Burners shall be of in-shot type fabricated of aluminum coated steel or stainless steel.
10. Gas piping shall enter unit cabinet at a single location.
11. Integrated Controls shall provide following:
    1. Timed control of evaporator fan functioning and burner ignition,
    2. Anti-cycle protection for gas heat operation (after one cycle on high temperature limit switch and one cycle on flame rollout switch).
    3. Diagnostic information.
12. Induced draft motor shall be provided with permanently lubricated, sealed bearings and inherent automatic reset thermal overload protection.
13. Controls, Safeties and Diagnostic Points:
14. Unit Controls: Unit shall be furnished with self-contained, BACnet MS/TP Direct Digital Controls.
15. Controls shall be factory-installed.
16. Controls shall operate with zone control systems.
17. Controls shall furnish built-in diagnostics for thermostat/sensor commands for staged heating and cooling, evaporator-fan operation, and economizer operation.
18. Controls shall be furnished with a 5-minute time delay between modes of operation.
19. Control circuit shall be protected by a fuse on 24-V transformer side.
20. Control shall incorporate passive infrared detection for sensing occupancy in space serve.
21. Compressor high temperature, high current, internal overloads, internal thermostat.
    1. Compressor reverse rotation protection.
    2. Loss-of-charge/low-pressure switch.
    3. Freeze-protection thermostat, evaporator coil.
    4. High-pressure switch.
    5. Internal relief valve.
    6. Anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
22. Heating section shall be provided with following minimum protections:
    1. High-temperature limit switches.
    2. Induced draft motor speed sensor.
    3. Flame rollout switch.
    4. Flame proving controls.
    5. Redundant main gas valve.
    6. Heating controls shall consist of:
23. 2-stage automatic combination gas valve.
24. Pressure regulator.
25. Electric spark intermittent ignition system or hot surface ignition system.
26. Time delay fan control.
27. Operating Characteristics:
    1. Unit shall be capable of starting and operating at 125 degrees F ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 210/240 or 360 at plus or minus 10 percent voltage.
    2. Compressor with standard controls shall be capable of operation down to 25 degrees F ambient outdoor temperature.
28. EMS Diagnostic Points: Provide diagnostic points for units, including those at projects with no EMS.
29. Supply air temperature.
30. Return air temperature.
31. Space temperature.
32. Outdoor air temperature.
33. Filter status, via pressure transducer on analog point.
34. Fan status.
35. Compressor status.
36. Economizer damper current position.
37. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
38. Filter Section:

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| **EDIT NOTE: IF THE PROJECT IS TO COMPLY WITH COLLABORATIVE FOR HIGH PERFORMANCE SCHOOLS (CHPS), THEN EDIT MERV RATING IN ACCORDANCE WITH CHPS’S REQUIREMENT.** |

1. Provide filter section with factory-installed low-velocity, throwaway, 4-inch or 2-inch thick high capacity, MERV 13 Class 2, filters of commercially available sizes unless noted otherwise on the drawings.
2. Filter face velocity shall not exceed 300 fpm at nominal airflows.
3. Filter section shall allow installation of standard size air filter.
4. Return air filters shall be accessible through a hinged access panel using standard size filters.

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| **EDIT NOTE: PROVIDE 100 PERCENT OUTDOOR AIR ECONOMIZERS FOR THE UMTS WITH CAPACITIES EQUAL TO. OR LARGER THAN 4.5 TONS NOMINAL CAPACITY. WHEN THE PRESCRIPTIVE COMPLIANCE APPROACH IS UTILIZED TO COMPLY WITH ENERGY EFFICIENCY STANDARDS OR WHERE NECESSARY TO ACHIEVE CHPS PREREQUISITE AND/OR CHPS BUILDING FLUSH-OUT COMPLIANCE. DELETE RELATED INFORMATION NOT APPLICABLE TO THE PROJECT.** |

1. 100 Percent Outdoor Air Economizer:
2. Provide 100 percent outdoor air economizers as indicated on drawings.
3. Gear-driven integrated economizers.
4. Integrated integral-modulating type capable of simultaneous economizer and compressor operation.
5. Furnish hardware and controls to provide cooling with outdoor air.
6. Low-leakage dampers not to exceed 3 percent leakage, at one inch wg pressure differential (variable sliding economizer).
7. Barometric relief damper. Damper shall close upon unit shutoff.
8. Differential temperature and enthalpy controller unless indicated otherwise on drawings.

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| **EDIT NOTE: PROVIDE UNITS WITH POWER EXHAUST WHEREVER ACCOMMODATING BAROMETRIC RELIEF DAMPER IS NOT FEASIBLE. DELETE RELATED INFORMATION NOT APPLICABLE TO THE PROJECT.** |

1. Provide units with centrifugal power exhaust controlled by a pressure sensor in space or outdoor air measurement and tracking as indicated on drawings. The controller shall modulate VFD in centrifugal power exhaust to maintain a pressure differential of 0.03 inch of water between indoor and atmospheric pressure. Furnish field wiring to power exhaust and install tubing in space. Provide other accessories as required to comply with UL or ETL requirements.
2. Base Rail: Factory installed on both horizontal and down-flow units.
3. Dampers Using Electronic Actuators:
   1. Manufacturer: Belimo, Honeywell, Invensys, Johnson Controls, or equal.
   2. Size for torque required for damper seal at load conditions.
   3. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
   4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent damage to the actuator during a stall condition.
   5. Fail-Safe Operation: Mechanical, spring-return mechanism.
   6. Power Requirements: Maximum of 10 VA at 24 VAC or 8 W at 24 VDC.
   7. Proportional Actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through EEPROM without the use of actuator mounted switches.
   8. Actuators shall be listed by ISO 9001, ULC, and CSA C22.2.

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| **EDIT NOTE: DELETE PARAGRAPH 2.02.N BELOW IF EMS IS USED.** |

1. Furnish programmable digital thermostat with following features for single zone units that are not provided with variable volume and variable temperature type controls:
2. 7-day time clock.
3. Heat, cool, automatic changeover.
4. Occupied/unoccupied modes.
5. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors, and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
6. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in PIR occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.
7. Demand Controlled Ventilation:
8. Units with 100 percent outdoor air economizers shall be provided with Indoor Air Quality (CO2) Sensor and Accessory Electronic Expansion Boards.
9. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
10. The IAQ sensor shall be wall mounted unless otherwise indicated on Drawings. The set point shall be adjustable.
11. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
12. The IAQ sensor shall provide a 0-10 VDC signal to expansion board.
13. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of the replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

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| **EDIT NOTE: USE OF SPLIT SYSTEMS REQUIRES DISTRICT’S APPROVAL PRIOR TO DESIGN.** |

**2.03. COOLING ONLY FAN COIL UNITS AND CONDENSING UNITS**

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| **EDIT NOTE: EDIT ACCEPTABLE MANUFACTURERS FROM THE LIST BELOW TO BE CONSISTENT WITH PARAGRAPH 2.03D.** |

1. Manufacturer: Carrier or Trane.

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| **EDIT NOTE: SELECT BASIS OF DESIGN FROM THE OPTIONS PRESENTED BELOW, DELETE UNUSED OPTIONS.** |

1. Basis of Design: [Carrier] [Trane]

1. FCU and CU: Furnish fan coil unit (FCU) and condensing unit (CU), split type, air-cooled, roof or ground for ducted connections or free blow. Units shall be air-cooled condensing unit/direct expansion fan coil combinations. Condensing unit outdoor section shall be factory assembled with a direct-drive condenser fans with horizontal or vertical air discharge, scroll-type compressor, refrigerant coil, fan motors, pre-wired control panel and a holding charge of a non-ozone depleting refrigerant. Contractor shall provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include evaporator coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Unit shall provide an EER/SEER complying with CCR, Title 24, Building Energy Efficiency Standards for Residential and Nonresidential Buildings. UL listed and rated at AHRI Standard 210/240.
2. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
3. Condenser coils:

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| **EDIT NOTE: EDIT ACCEPTABLE CONDENSER COIL TYPE FROM THE LIST BELOW TO BE CONSISTENT WITH BASIS OF DESIGN EQUIPMENT SELECTION. DELETE UNUSED COIL TYPES.** |

1. Acceptable Condenser Coils:
   1. Copper-tube, aluminum-fin coil, with liquid subcooler. Internally enhanced 3/8-inch outside diameter, seamless copper tubing mechanically bonded to aluminum fins with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.
   2. Spine Fin™ condenser coil shall be continuously wrapped, corrosion resistant aluminum with minimum brazed joints. This coil is 3/8 inch outside diameter seamless aluminum tubing glued to a continuous aluminum fin. Coils are lab tested to withstand 2,000 pounds of pressure per square inch. The outdoor coil provides low airflow resistance and efficient heat transfer. The coil is protected on four sides by louvered panels.
   3. Coil shall be air-cooled Micro-Channel heat exchanger technology (MCHX) and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a factory applied Corrosion-Resistant Epoxy Coating. Provide Protective Hail Guard.

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| **EDIT NOTE: IF PROJECT IS LOCATED WITHIN TWO MILES FROM THE OCEAN DELETE ARTICLE D ABOVE AND EDIT PARAGRAPH 2.03A TO INCLUDE ONLY MANUFACTURERS WHICH CAN SUPPLY COPPER –TUBE, COPPER FIN COILS, AND USE PARAGRAPH BELOW.   DELETE PARAGRAPH D BELOW IF IT DOES NOT APPLY TO THE PROJECT.** |

1. Condenser Coils shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints and with factory applied Corrosion-Resistance Epoxy Coating. Field coated coils are not acceptable.
2. Evaporator coils:
3. Aluminum plate fins mechanically bonded to enhanced copper tubes with joints brazed and factory applied Corrosion-Resistance Epoxy Coating.
4. Tube sheet openings shall be belled to prevent tube wear.
5. Evaporator coil shall be of full-face active design. Dual circuit models shall have face-split type evaporator coil.

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| **EDIT NOTE: IF PROJECT IS LOCATED WITHIN TWO MILES FROM THE OCEAN DELETE ARTICLE E ABOVE AND YORK FROM PARAGRAPH 2.03.A, AND USE PARAGRAPH BELOW.   DELETE PARAGRAPH E BELOW IF IT DOES NOT APPLY TO THE PROJECT.** |

1. Evaporator Coils at locations within two miles from ocean shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints and with factory applied Corrosion-Resistance Epoxy Coating. Field coated coils are not acceptable.
2. Condenser Fan and Motors: Condenser fan shall be a dynamically balanced, propeller type, fabricated of aluminum blades riveted to corrosion resistant steel spiders and direct-driven by a totally enclosed motor. Condenser air shall be discharged horizontally or vertically. Condenser fan motors shall be high efficiency or ECM type motor.
3. Cabinets: Fabricated of galvanized steel, bonderized and finished with baked enamel.
4. Compressor shall be serviceable two stage or variable speed type hermetic scroll. Compressor shall be furnished with access valves and shall be installed on rubber isolators to reduce sound vibration. It shall be furnished with high and low-pressure protection. Each horizontal discharge condensing unit shall be furnished with a factory installed suction accumulator. Field installed accumulators are not permitted. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
5. Controls: Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle. Unit shall incorporate an automatic relay for indoor circulating air blower. Control panel shall be pre-wired in unit casing. The control circuit shall incorporate a manual reset safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of airflow or refrigerant. Units shall also be furnished with automatic condenser-fan motor protection, high condensing temperature protection, compressor motor current and temperature overload protection, high pressure relief, and condenser fan failure protection.

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| **EDIT NOTE: DELETE PARAGRAPH J BELOW IF EMS NOT IN PROJECT SCOPE.** |

1. EMS Diagnostic Points:
   1. Supply air temperature.
   2. Return air temperature.
   3. Space temperature.
   4. Filter status, via Pressure transducer on analog point.
   5. Fan status.
   6. Compressor status.
   7. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
2. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.
3. Filters: Filters shall be 2-inch standard size high capacity replaceable media type MERV 13, installed in an external 2-inch rack filter section and complete with an access door.
4. An in-line filter-drier shall be provided with equipment and shall be installed at Project site.
5. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.

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| **EDIT NOTE: USE OF HEAT PUMPS REQUIRES DISTRICT’S APPROVAL PRIOR TO DESIGN.** |

**2.04. HEAT PUMP AND FAN COIL UNITS**

* 1. Manufacturer: Carrier or Trane.

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| **EDIT NOTE: SELECT BASIS OF DESIGN FROM THE OPTIONS PRESENTED BELOW; DELETE UNUSED OPTIONS.** |

1. Basis of Design: [Carrier] [Trane]
   1. Heat Pump matching indoor fan coil and Outdoor unit: Furnish heat pump, split type, air-cooled, roof or ground installation with ducted connections or free blow. Units shall be air-cooled heat pump/direct expansion fan coil combinations. Heat pump outdoor section shall be factory assembled and furnished with direct-drive Outdoor fans with horizontal or vertical air discharge, scroll type compressor, refrigerant coil, fan motors, pre-wired control panel. Unit shall also be provided with a fully piped refrigerant circuit, fully charged with an environmentally friendly refrigerant that is not scheduled for phase out. Provide additional refrigerant for extended lines. Indoor fan coil unit shall be furnished with horizontal discharge and will include Indoor coil, fan and motor, condensate pan with drain, thermal expansion valve, pre-wired control panel and remote thermostat control. Nominal unit cooling, heating capacities, electrical characteristics, and operating conditions shall be as indicated on Drawings.
   2. Quality Assurance:
2. Cooling capacity rated in accordance with current AHRI Standard 210/240 and 270. Units shall be listed in AHRI.
3. Unit construction shall comply with ANSI/ASHRAE 15, latest revision, and with NEC.
4. Units shall be constructed in accordance with UL standards and shall carry UL/ETL label of approval.
5. Units shall be listed in CEC directory.
6. Unit cabinet shall be capable of withstanding ASTM B117 500 hour salt spray test.
7. Unit shall provide an EER/SEER/COP complying with CCR, Title 24, Building Energy Efficiency Standards and per the drawings.
   1. Indoor and Outdoor coils: Indoor and Outdoor coils shall be copper with mechanically bonded, smooth aluminum plate fins. Tube joints shall be brazed with copper or silver alloy. Coils shall be pressure-tested at factory. Protective metal guard for inlet and outlet of outdoor coil.

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| **EDIT NOTE: IF PROJECT IS LOCATED WITHIN TWO MILES FROM THE OCEAN DELETE ARTICLE D ABOVE AND YORK FROM PARAGRAPH 2.04.A, AND USE PARAGRAPH BELOW.   DELETE PARAGRAPH D BELOW IF IT DOES NOT APPLY TO THE PROJECT.** |

* 1. Indoor and Outdoor Coils at locations within two miles from ocean shall be furnished with copper plate fins mechanically bonded to enhanced copper tubes with copper tube sheets and brazed joints and with factory applied Corrosion-Resistance Epoxy Coating. Field coated coils are not acceptable.
  2. Fans:
  3. Outdoor Fan and Motors: Outdoor fan shall be ECM type motor direct driven, propeller type arranged for horizontal or vertical discharge. Outdoor fan motors shall be furnished with inherent protection, and shall be permanently lubricated type, resiliently mounted for quiet operation. Each fan shall be furnished with a safety guard.
  4. Indoor fan section shall be furnished with ECM type motor centrifugal, forward curved, double width, double inlet fan or fans installed on a solid shaft. Fan shall be statically and dynamically balanced and shall rotate on permanently lubricated bearings.
  5. Unit Cabinets:

1. Cabinets shall be fabricated of galvanized steel, bonderized and finished with baked enamel.
2. Cabinet interior shall be insulated with minimum one inch thick foil face fiberglass.
3. Outdoor unit compartment shall be isolated and have an acoustic lining to assure quiet operation.
   1. Compressor: Compressor shall be two stage or variable speed type hermetic scroll.
4. Compressor shall be furnished with access valves and it shall be installed on rubber isolators to reduce sound vibration.
5. Furnish with high and low-pressure protection.
6. Each heat pump shall be furnished with factory installed suction accumulator. Field installed accumulators are not permitted.
7. It shall be furnished with high and low-pressure protection, brass external vapor supply line service valves, vapor return line service valves with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps, filter drier, pressure relief, liquid line solenoid valves, thermostatic expansion valves, and a holding charge of refrigerant.
   1. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, bi-flow filter drier, pressure relief, reversing valve, heating mode metering device, and a holding charge of refrigerant.
   2. Controls and Safeties:
8. Compressor motor assembly shall be protected with high and low-pressure switches, internal overloads, internal thermostat, internal relief valve, and anti-recycle relay, or time cycle device to prevent rapid cycling of compressor after any off cycle.
9. Control panel shall be pre-wired in unit casing.
10. The control circuit shall incorporate a safety circuit to render refrigerant system (compressor and outdoor air motor) inoperative should there be a loss of refrigerant.
11. Units shall also be furnished with automatic Outdoor-fan motor protection, high condensing temperature protection, compressor motor current and temperature overload protection, high pressure relief and Outdoor fan failure protection.

|  |
| --- |
| **EDIT NOTE: DELETE PARAGRAPH 2.04.J BELOW IF EMS NOT IN PROJECT SCOPE.** |

* 1. EMS Diagnostic Points:
  2. Supply air temperature.
  3. Return air temperature.
  4. Space temperature.
  5. Filter status, via Pressure transducer on analog point.
  6. Fan status.
  7. Compressor status.
  8. Other diagnostic point required by current Title 24, automated fault detection and diagnostics (FDD).
  9. Low Ambient Operation: Head pressure control shall be provided for operation at outside air temperature below 45 degrees F.
  10. Safeties:

1. High condensing temperature protection.
2. Compressor motor current and temperature overload protection.
3. High pressure relief.
4. Outdoor fan failure protection.
   1. Filters:
5. Filters shall be 2-inch standard size high capacity replaceable media type, MERV 13, installed in an external 2-inch rack filter section and complete with an access door.
6. An-line filter-drier shall be furnished with equipment and installed at Project site.
   1. Economizer: Provide on units with capacities equal to, or larger than 4.5 tons nominal capacity, when the Prescriptive Compliance approach is utilized to comply with Energy Efficiency Standards or where necessary to achieve CHPS pre-requisite and/or CHPS building flush-out compliance. Economizer shall be manufacturer's standard; factory furnished and field installed. Economizer control shall maintain a fixed supply air temperature during free cooling operation by providing full modulation of operable outside and return air dampers.
   2. Provide programmable digital thermostat with following features:
   3. 7-day time clock.
   4. Heat, cool, automatic changeover.
   5. Occupied / Unoccupied modes.
   6. Dry contact switch for input from an external device such as a central time clock, occupancy sensor, or a telephone activated device.
   7. Robertshaw, Honeywell, Johnson Controls, Carrier, Schneider Electric, Viconics, or equal with built-in occupancy sensor. Refer to Section 23 0900 for areas with zone damper controls.
   8. Remote sensors. School Areas that could be subject to vandalism or accidental impact damage such as Gymnasiums, Auditoriums, Multipurpose Rooms, Corridors and Lobbies shall be provided with thermostats with remote return air duct or room sensors. Verify remote location of sensors and thermostats with Architect.
   9. P. Demand Control Ventilation:
7. Units of 6.25 nominal tons and higher capacity shall be provided with Indoor Air Quality (CO2) Sensor and Accessory Electronic Expansion Boards.
8. The unit shall have ability to provide demand ventilation indoor-air quality (IAQ) control through economizer when provided with an indoor air quality sensor and accessory expansion board.
9. The IAQ sensor shall be duct mounted in return air main duct unless otherwise indicated on Drawings. The set point shall be adjustable.
10. The IAQ sensor shall be powered through unit. If not, required control transformer shall be provided by manufacturer. Coordinate power requirements and location with Division 26.
11. The IAQ sensor shall provide a 4 to 20 mA signal to expansion board.
    1. Start-up: Factory test each unit before shipment to Project site. Performance test shall include full refrigeration start-up, fan and controls start-up. Each unit shall be provided with its own report with its own serial number. Non-tested units are not permitted to be delivered to Project site. Provide full start-up of units to include full refrigeration and provide a written report.
    2. Parts Availability: Submit proof in writing that majority (minimum 80 percent) of replacements parts are commonly available and not proprietary. Also, submit proof in writing that a local parts sales and service facility exists, where replacement parts will be warehoused in quantity. Guarantee timely availability for parts that are proprietary.

**2.05 ROOF MOUNTED POWER EXHAUST VENTILATORS**

* 1. RMEV-1
  2. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VEBK Series | GB Series | ACEB | Domex - Belt Drive | BCRD |  |

* 1. Spun aluminum, roof mounted, belt driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Provide required accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
  2. Certification: Fan shall be listed by Underwriters Laboratories Inc (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
  3. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.
  4. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
  5. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
  6. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
  7. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision-machined cast iron type, or heavy gauge galvanized steel, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.
  8. RMEV-2:

1. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VEDK Series | G Series | ACED | Domex - Direct Drive | DCRD |  |

1. Spun aluminum, roof mounted, direct driven, downblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
2. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
3. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The discharge baffle shall have a rolled bead for added strength. An integral conduit chase shall be provided through curb cap and into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
4. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.
   1. RMEV-3:
6. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VUBK Series | CUBE Series | ACRUB | Fumex-Belt Drive | BCRU |  |

1. Spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
2. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
3. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. A two piece top cap shall have stainless steel, or galvanized quick release latches to provide access into motor compartment without use of tools, or screws. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 16 gage steel power assembly, isolated from unit structure with rubber vibration isolators. These components shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate.
4. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
6. Bearing: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
7. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron, or galvanized steel type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.
   1. RMEV-4:
8. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VUDK Series | CUE Series | ACRUD | Fumex-Direct Drive | DCRU |  |

1. Spun aluminum, roof mounted, direct driven, upblast centrifugal exhaust ventilator, with components as indicated and specified. Sizes, performances, and accessories shall be as indicated on equipment schedules on Drawings. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
2. Certification: Fan shall be listed by Underwriters Laboratories Inc. (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
3. Housing: Fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. An integral conduit chase shall be provided into motor compartment to facilitate wiring connections. The motor shall be enclosed in a weather-tight compartment, separated from exhaust airstream. Unit shall bear an engraved aluminum nameplate.
4. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. An aerodynamic aluminum inlet cone shall be provided for maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. Motor: Motor shall be heavy-duty ECM type with permanently lubricated sealed bearings and furnished at specified voltage, phase, and enclosure.

**2.06 INLINE FANS**

* 1. ILF-1: (Used as Garage Exhaust Fan GEF-1)
  2. Manufacturer:

|  |  |  |  |
| --- | --- | --- | --- |
| GREENHECK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| QEI or QEID | ESI | QSL |  |

* 1. Provide inline mixed flow type fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
  2. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA certified ratings seal for sound and air performance.
  3. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The housing shall be of minimum 12 gage steel. Bearing supports shall be minimum 10 gage welded steel. Lifting eyes shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
  4. Finish: Steel fan components shall be coated with polyester powder coating to exceed 1,000 hour salt spray test under ASTM B117 test method.
  5. Wheel: Wheel shall be of mixed flow type with a wheel cone, spherical back plate and single thickness cambered blades, or formed hollow airfoil blades continuously welded to back plate. Hub shall be keyed and securely attached to fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
  6. Motor: Motor shall be ECM type, voltage and phase, as indicated on drawings. Provide permanently lubricated sealed ball bearings. Option: Energy efficient motor meets EPAct and NEMA Table 12-10.
  7. Shaft: Blower shaft shall be AISI C1045/SAE 1045, or 1040 hot rolled and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
  8. Bearings: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing and selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
  9. Drive: Fans shall be direct drive or belt driven as indicated on drawings.
  10. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

**2.07 CEILING CABINET FANS**

1. CCF-1:
   1. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VCDK or VCDD Series | SP or CSP Series | GC 200 or 900 Series | Zephyr Fans | T or TL Series |  |

* 1. Provide ceiling, wall, or inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
  2. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
  3. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different ceiling thickness, an adjustable prepunched mounting bracket shall be provided. A powder painted white steel grille shall be provided as standard.
  4. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
  5. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.

1. CCF-2:
2. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VCDK or VCDD Series | CSP Series | GN 200 or 900 Series | Zephyr Fans | TL Series |  |

1. Provide inline mounted, direct driven, centrifugal exhaust fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
2. Certification: Fan shall be listed by Underwriters Laboratories (UL 507 & 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance.
3. Housing: The fan housing shall be minimum 22 gage galvanized steel and acoustically insulated. Blower and motor assembly shall be mounted to a minimum 16 gage reinforcing channel and shall be easily removable from housing. Motor shall be mounted on vibration isolators. Unit shall be supplied with integral wiring box and disconnect receptacle shall be standard. Discharge position shall be convertible from right angle to straight through by moving interchangeable panels. The outlet duct collar shall include a reinforced aluminum damper with continuous aluminum hinge rod and brass bushings. To accommodate different mounting positions, an adjustable pre-punched mounting bracket shall be provided.
4. Wheel: Wheel shall be centrifugal forward curved type, constructed of galvanized steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. Motor: Motor shall be ECM type with permanently lubricated bearings, built-in thermal overload protection and disconnect plug. Motor shall be furnished at specified voltage.
6. CCF-3:
7. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VDBA or VGBA Series | BCF Series | DB | Zephyr Cabinet Fans | DBS or DBT |  |

1. Provide duct mounted, belt driven centrifugal cabinet fans of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.
2. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seals for Fan Sound and Air Performance.
3. Housing: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 22 gage galvanized steel with two access doors and integral duct collars. Internal blower and motor assembly shall be mounted on rubber vibration isolators. Hanging brackets shall be provided for horizontal installation. Unit shall bear an engraved aluminum nameplate.
4. Wheel: Wheel shall be DWDI centrifugal forward curved type, constructed of painted steel. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
5. Motor: Motor shall be heavy duty TEFC inverter duty type with permanently lubricated sealed ball bearings and furnished at specified voltage and phase.
6. Bearing: Bearings shall be permanently lubricated, sealed ball type selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
7. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

**2.08 GRAVITY EXHAUST/INTAKE VENTILATORS**

1. GEIV-1:
   1. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| GSAA Series | GRS Series | PR or TR | WCC | GRV |  |

* 1. Spun aluminum, roof mounted gravity ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation of ventilators per code and in accordance with design intent and sequence of operation.
  2. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 18 gage Aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength. Birdscreen constructed of 1/2" mesh shall be mounted across air opening. Unit shall bear an engraved aluminum nameplate.
  3. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01” static pressure.
  4. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

1. GEIV-2:
2. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| GEAB Series | FGR Series | GR | AEG Relief | MGR |  |

1. Provide hooded aluminum, roof mounted gravity relief ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
2. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 12 gage Aluminum 5052, hinged to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across relief opening. Unit shall bear an engraved aluminum nameplate.
3. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
4. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.
5. GEIV-3:
6. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| GIAB Series | FGI Series | GI | AEG Intake | MGI |  |

1. Provide hooded aluminum, roof mounted gravity intake ventilators of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of ventilators. Also, provide accessories for proper operation and balancing of ventilators in accordance with design intent and sequence of operation.
2. Housing: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood interlocking panels shall be constructed of minimum 18 gage Aluminum, bolted to a minimum 12 gage aluminum 5052 support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of ½ inch mesh shall be mounted across intake opening. Unit shall bear an engraved aluminum nameplate. Units shall be provided with bird screen and anti-condensate coating as standard.
3. Provide gravity type back-draft or relief dampers at relief or exhaust ventilators (with counterweights if required). Gravity relief dampers shall fully open at 0.01 inch static pressure.
4. Intake ventilators shall be provided with normally closed, motorized dampers that are interlocked with fan to open upon fan activation unless fan is provided with such a damper.

**2.09 FUME HOOD EXHAUST**

1. FHE-1:
   1. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VBBB Series | SWB Series | CPV | Dynamo | BCV |  |

* 1. Fume Hood Exhaust: Provide single width, single inlet, backward inclined aluminum wheel, belt driven centrifugal vent sets of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.

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| --- |
| **EDIT NOTE: DELETE PARAGRAPH 2.09.A.2.a BELOW WHEN NEW FUME HOODS ARE INSTALLED.** |

1. Provide the existing fume hood with airflow measuring device indicating the rate of inward airflow as a quantitative airflow monitor with audible alarm that continuously indicates whether air is flowing into the exhaust system during operation.
   1. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seal for Sound and Air Performance and be manufactured with Type C spark resistant construction.
   2. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be minimum 14 gage steel with scroll drain and scroll side panels shall be minimum 14 gage steel. The entire fan housing shall have continuously welded seams for leakproof operation. A performance cut-off shall be furnished to prevent recirculation of air in fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1 ½-inch outlet discharge flange. Bearing support shall be minimum 10 gage welded steel. Side access inspection ports shall be provided with quick release latches for access to motor compartment without removing weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
   3. Finish: Exterior steel fan components shall be an electrostatically applied, baked epoxy powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2.5 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method. Interior and exterior parts of the fan exposed to the air being moved shall be coated with minimum 15 mils of baked epoxy.
   4. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel hub shall be keyed and securely attached to fan shaft. Wheel inlet shall overlap a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
   5. Motor: Motor shall be heavy-duty, explosion proof type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
   6. Shaft: Blower shaft shall be AISI C1045/SAE 1045 hot rolled and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
   7. Bearing: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy-duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
   8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.
2. FHE-2:
   1. Manufacturer:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CARNES | GREENHECK | LOREN COOK | PENNBARRY | TWIN CITY & BLOWER | OR EQUAL |
| VBBB Series | SWB Series | CPS | Dynamo | BCV |  |

* 1. Provide single width, single inlet, backward inclined steel wheel, belt driven centrifugal vent sets of sizes, capacities and configurations indicated on drawings, complete with accessories for installation of fans. Also, provide accessories for proper operation and balancing of fans in accordance with design intent and sequence of operation.

|  |
| --- |
| **EDIT NOTE: DELETE PARAGRAPH 2.09.B.2.a BELOW WHEN NEW FUME HOODS ARE INSTALLED.** |

1. Provide the existing fume hood with airflow measuring device indicating the rate of inward airflow as a quantitative airflow monitor that continuously indicates whether air is flowing into the exhaust system during operation.
   1. Certification: Fan shall be listed by Underwriters Laboratories (UL 705). Fan shall bear AMCA Certified Ratings Seal for Sound, Air Performance and be manufactured with Type C spark resistant construction.
   2. Housing: The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The scroll wrapper shall be a minimum 14 gage steel with scroll drain and scroll side panels shall be a minimum 12 gage steel. The entire fan housing shall have continuously welded seams for leak proof operation. A performance cut-off shall be furnished to prevent re-circulation of air in fan housing. The fan housing shall be field rotatable to any one of eight discharge positions and shall have a minimum 1 ½-inch outlet discharge flange. Bearing support shall be minimum 10 gage welded steel. Side access inspection ports shall be provided with quick release latches for access to motor compartment without removing weather cover. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate.
   3. Finish: Steel fan components shall be an electrostatically applied, baked epoxy powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2.5 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method. Interior and exterior parts of the fan exposed to the air being moved shall be coated with minimum 15 mils of baked epoxy.
   4. Wheel: Wheel shall be steel centrifugal backward inclined, non-overloading flat blade type. Blades shall be continuously welded to backplate and deep spun inlet shroud. Wheel hub shall be keyed and securely attached to fan shaft. Wheel inlet shall overlap a one piece aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204, Balance Quality and Vibration Levels for Fans.
   5. Motor: Motor shall be heavy-duty, explosion proof type with permanently lubricated sealed ball bearings and furnished at specified voltage, phase, and enclosure.
   6. Bearing: Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty re-greasable anti friction ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
   7. Shaft: Blower shaft shall be AISI C1045/SAE 1045 hot rolled steel and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 143 percent of maximum RPM.
   8. Belts and Drives: Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to wheel and motor shafts. Drives shall be sized for 150 percent of installed motor horsepower. The variable pitch motor drive must be factory set to specified fan RPM.

**2.10 FILTERS**

1. Air filter media shall be minimum 2-inch thick, MERV 13 Class 2, 100% synthetic, high capacity, pleated, disposable type, with support grid and enclosing frame, continuously laminated on a supporting moisture resistant beverage board type frame that conforms to the configuration of the pleats. Media shall be glued to the frame along all four sides and glued horizontally & diagonally to grill members on both sides. The media shall be unaffected by water and humidity, be non-toxic, non-allergenic, and shall not support the growth of any fungi or bacteria. Filter shall have rigid outer frame that will not bend or distort under normal usage. Filter shall be UL 900 listed, Class 2.
2. Filter media shall provide an average efficiency as specified on drawings per ASHRAE Standard 52.2.
3. Initial resistance of air filters shall not exceed following limits for each efficiency level at face velocities indicated. Lower resistance requirements, if indicated on drawings shall have precedence.

85 percent (MERV 13) 0.30 inch water gage at 500 feet per minute

95 percent (MERV 14) 0.38 inch water gage at 500 feet per minute

1. Use standard size Filter Medias only.
2. Media support shall be a welded wire grid or a rigid frame with an effective open area of not less than 96 percent.
   1. Media support shall be bonded to filter media to eliminate possibility of media oscillation and media pull-away.
   2. Media support grid shall be formed in such a manner that it effectively forms a radial pleat design, providing total use of filter media.
3. Enclosing frame shall be bonded to air entering and air exit side of each pleat, to ensure pleat stability. Inside periphery of enclosing frame shall be bonded to filter pack, thus eliminating possibility of air bypass.
4. Holding frames shall be factory fabricated of 16 gage galvanized steel, or equivalent and shall be furnished with gaskets and spring type positive sealing fasteners. Fasteners shall be capable of being attached or removed without use of tools.
5. Manufacturers: Camfil Farr, Koch, or AAF.

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| **EDIT NOTE: EDIT ARTICLE BELOW FOR STANDARD TYPE LOUVERS. ARCHITECTURAL LOUVERS SHOULD BE SPECIFIED IN SPEC SECTION 07 6000. ENSURE PARAMETERS SUCH AS FREE AREA, PRESSURE DROP AND WATER PENETRATION ARE CONSIDERED.** |

**2.11 LOUVERS, AIR CONDITIONING (use in conjunction with relief damper)**

* 1. Standard steel louvers shall be furnished complete with frames, blades, finish and construction details per Drawings and manufacturer’s recommendations.
  2. Louvers shall be furnished with horizontal blades, 2 inches deep for air through wall installation in conjunction with gravity relief damper for backdraft protection that will open at 0.01-inch wc room static pressure as indicated on Drawings. Blades shall be 16-gage steel, spaced at 1 7/8-inch at 30 degrees angle, and with baked epoxy coating. Panel size shall be as indicated but not less than 24 inches width by 18 inches in height.

**PART 3 – EXECUTION**

* 1. **GENERAL**
  2. Examine areas under which Work of this Section will be performed. Correct conditions detrimental to proper and timely completion of Work. Do not proceed until unsatisfactory conditions have been corrected.
  3. **EQUIPMENT FOUNDATIONS**

1. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Equipment foundations shall be of sufficient size and weight, and of proper design to preclude shifting of equipment under operating conditions, or under abnormal conditions imposed upon equipment.
2. Provide foundations (housekeeping pads, level platforms or curbs) for mechanical equipment whether indicated on drawings or not. Foundations shall meet requirements of equipment manufacturer and, when required by Architect, obtain from equipment manufacturer, approval of foundation design and construction, for equipment to be installed. Equipment vibration shall be maintained within design limits, and shall be dampened and isolated. Isolators shall be bolted to a structural member so as to be readily removable.
   1. **EQUIPMENT DESIGN AND INSTALLATION**
3. Uniformity: Unless otherwise specified, equipment of same type or classification shall be product of same manufacturer.
4. Application: Only provide equipment as reviewed by Architect.
5. Equipment Installation: Equipment installation shall be in strict accordance with these Specifications, and installation instructions of manufacturers. Equipment installed on concrete foundations shall be grouted before piping is installed. Piping shall be installed in such a manner as not to place a strain on equipment. Flanged joints shall be adequately extended before installation. Piping shall be graded, anchored, guided and supported, without low pockets.
   1. Install equipment in a neat and skillful manner, properly aligned, leveled, and adjusted for satisfactory operation.
   2. Install so connecting and disconnecting of piping and accessories can be readily accomplished, parts are readily accessible for inspection, service and repair. Space shall be provided to readily remove filters, coils, compressors and fan wheels. Access doors shall be hinged with cam lock door handles.
   3. Provide flexible connections for duct, pipe and conduit connections at moving equipment.
   4. **ROOF-TOP EQUIPMENT MOUNTING**
   5. Downflow Packaged Units: Install unit on a prefabric­ated mounting frame or curb secured directly to roof. Follow manufacturers recommended installation manuals. Submit Shop Drawings for review by Architect.
   6. Horizontal Flow Packaged Units: Install unit on platform or prefabricated mounting frame or curb secured directly to roof designed to suit roof conditions and requirements of provided unit. Submit Shop Drawings for review by Architect.
   7. **REFRIGERANT PIPING INSTALATION**
   8. Unless otherwise indicated, main liquid and suction lines from condensing unit to Indoor coil shall be of sizes specified by manufacturer.
   9. Refrigeration piping shall be refrigeration grade copper tubing, type L hard-drawn. In instances where refrigeration lines are installed in an inaccessible location and must be snaked through conduit or a trench, that portion of tubing required to complete connections through conduit or trench may be soft drawn. Maintain entire system clean and dry during installation. Pipe shall be sealed until installed.
   10. Refrigeration piping, both hard and soft-drawn, shall be straight and free from kinks, restrictions and horizontal runs shall be sloped towards compressor one inch to 10 feet wherever possible. Vapor line oil traps shall be installed on bottom of vertical risers and inverted oil trap shall be installed on top of vertical risers.
   11. Joints shall be installed with Sil-Fos 15, Silvaloy 15, or equal.
   12. Flare nuts required on suction lines shall be of short forged or frost-proof type. Other fittings shall be standard sweat-soldered type. Ells and return bends shall be long radius type. Install leak lock material.
   13. Refrigeration Piping: Joints shall be silver brazed and tested according to the section 23 0500 “Common Work Results for HVAC”. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter. Field fabricated lines shall be thoroughly deburred, flushed and cleaned before connection. Bleed nitrogen through lines during silver brazing, maintain Nitrogen flow rate of 1.75 cubic feet per minute or more using a pressure regulator. Cap and seal lines when not completed and connected to equipment.
6. Brazing or Debrazing shall always be conducted with nitrogen purging through the refrigeration system.
7. Arrange a refrigerant piping pre-installation conference between Contractor, Architect, IOR, and OAR to review and confirm installation method.
8. Do not charge refrigerant through the split system prior to testing procedure by contractor and acceptance by District.
   1. Sleeve penetrations of floors, walls and ceiling to allow for free motion of piping. Provide 24 gage galvanized iron pipe and chrome-plated escutcheon plates. Pack annular space between pipe and sleeve with incombustible material such as fiberglass and seal each end with mastic to provide a waterproof seal.
   2. Install insulated couplings at points of connection between dissimilar metals for cathodic protection. Insulate copper tubing from ferrous materials and hangers with 2-inch thickness of 3-inch wide strip, 10 mil polyvinyl tape wrapped around pipe.
   3. Support piping by iron hangers and supports. Hydra-Zorb cushion clamps, LSP Products Group Acousto Clamp, or equal, on non-insulated piping, and Klo-Shure coupling clamp on insulated piping, or equal.
   4. Provide saddles to protect pipe insulation.
   5. Provide connections of copper, copper plated steel, steel, and brass pipe and tubing with Harris Products Group Safety-Silv 56, Lucas-Milhoupt, Inc., or equal, complying with ANSI/AWS A5.8 and NSF 51.
   6. Insulate refrigerant suction lines.
   7. On split systems, insulate both vapor and liquid lines. For insulation materials, refer to Section 23 07 00: HVAC Insulation.
   8. **NOISE AND VIBRATION**
9. Operation of Equipment: Mechanical equipment and piping systems shall operate without exceeding specified noise and/or vibration levels.
10. Corrective Measures: If specified noise and/or vibration levels are exceeded, provide necessary changes to reduce noise and/or vibration levels to within specified levels.
    1. **FIELD TESTS AND INSPECTION**
11. General: Perform field inspections, field tests, and trial operations as specified in Section 23 05 00: Common Work Results for HVAC. Provide labor, equipment and incidentals required for testing. The Project Inspector will witness field tests and trial operations as specified in Section 23 0500: Common Work Results for HVAC.
12. Equipment and Material: Equipment and material certified as being successfully tested by manufacturer, in accordance with referenced Specifications and standards, will not require re-testing before installation. Equipment and materials not tested at place of manufacture will be tested before or after installation, as applicable or necessary, to determine compliance with reference Specifications and standards.
13. Start-Up and Operational Test: System shall be started up and initially operated with components operating. During this test, various strainers or filters shall be periodically cleaned until no further accumulation of foreign material occurs. Adjust safety and automatic control instruments as required to provide proper operation and control sequence. Refer to Section 23 05 00: Common Work Results for HVAC.
14. Extent of Field Tests: After installation and before completion, Work of this Section shall be subjected to required field tests, including those specified here and in Section 23 05 00: Common Work Results for HVAC.
15. Operation and Maintenance Data: Provide required operation and maintenance data as specified in Section 23 05 00: Common Work Results for HVAC.
    1. **CLEANUP**

##### Remove rubbish, debris and waste materials and legally dispose of off Project site.

* 1. **PROTECTION**

1. Protect Work of this Section until Substantial Completion.

END OF SECTION