



PARTNERING in Energy Solutions



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Minimum Standards and Practices for Energy Solutions Partners



Rochester Public Utilities
Partnering in Energy Solutions Program

Table of Contents

Minimum Standards and Practices for Energy Solution Partners	Page 2
• Purpose	Page 2
• General ESP Requirements	Page 2
Minimum Equipment Standards	Page 4
• Lamps and Ballasts	Page 4
• Lighting Control	Page 5
• Motors	Page 6
• Variable Frequency Drives	Page 7
• Power Factor Capacitors	Page 8
• Cooling Equipment	Page 8
○ Air Cooled Condensing Units	Page 8
○ Centrifugal Water Chillers	Page 9
○ Rotary Screw Water Chillers	Page 12
○ Reciprocating Water Chillers	Page 15
○ Scroll Water Chillers	Page 19
• Geo-Thermal Ground Source Heat Pumps	Page 21
• Document Contributors and Sources	Page 23
• Document Revision List	Page 24

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Minimum Standards and Practices for Energy Solution Partners

PURPOSE:

Rochester Public Utilities (RPU) wants to insure their Customer that they will receive quality materials and workmanship when utilizing any of the Energy Solutions Partners (ESP) introduced through its Partnering in Energy Solutions Program.

Each contractor and consultant joining RPU's Partnering in Energy Solutions Program will be recommended to follow with the high quality standards outlined in this document.

GENERAL ESP REQUIREMENTS:

- Code/Standards Compliance: ESP's are required to comply with all applicable codes and industry standards which shall include but not be limited to the following:
 - National Fire Protection Agency (NFPA):
 - Comply with applicable provisions of ANSI/NFPA 70 "National Electric Code", pertaining to construction and installation of electrically operated components of packaged roof top air handling units.
 - Comply with applicable provisions of ANSI/NFPA 90A, "Air Conditioning and Ventilating Systems".
 - Underwriters Laboratory (UL):
 - Provide electrical components which have been listed and labeled by Underwriters Laboratories.
 - National Electrical Manufacturers Association (NEMA) Compliance:
 - Provide electrical components which meet or exceed minimum NEMA standards.
 - Provide lighting products that meet or exceed NEMA/CEE high performance lighting system specifications.
 - American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) Compliance:
 - Provide refrigerant coils complying with construction and testing standards of ANSI/ASHRAE 15 Safety Code for Mechanical Refrigeration.
 - Air-Conditioning and Refrigeration Institute (ARI) Certification:
 - Package roof top air handling units and their components shall be factory tested in accordance with the applicable portions of ARI-430 "Standard for Air Handling Units" and shall be listed and bear the label of the Air Conditioning and Refrigeration Institute.
 - Geo-Thermal systems and their components shall be rated in accordance with ARI-320, ARI-325 and ARI-330.

- International Ground Source Heat Pump Association (IGSHPA) Certification:
 - Installing contractors of geo-thermal systems shall have at least one employee who is IGSHPA certified present at all times during the installation of the system.
- Illumination Engineering Society (IES) Standards:
 - Comply with all standards for interior and exterior lighting quality and recommended lighting levels.
- Documentation: ESP's are required to provide the Customer with the following minimum documentation:
 - Product Data: Submit manufacturer's specifications for all equipment supplied showing dimensions, weights, capacities, ratings, efficiencies, electrical characteristics installation instructions, wiring diagrams detailing wiring for power and controls, etc.
 - Maintenance Data: Submit maintenance instructions and schedules, including lubrication requirements, filter replacement, motor and drive replacement components and recommended spare parts lists.
- Rebate Assistance: ESP's shall fill out rebate forms on behalf of the Customer, complete necessary calculations and provide documentation required to file for applicable rebates. ESP's will allow all rebates to go directly to the Customer.

MINIMUM EQUIPMENT STANDARDS

Lamps and Ballasts

- Linear Fluorescent Lamps
 - Acceptable Manufacturers: Philips, General Electric, Sylvania or pre-approved equivalent.
 - General Requirements:
 - T-8 lamps shall meet or exceed the following requirements: Low wattage (32, 28, or 25 watt), 800 series phosphor, 80+ CRI rating, 93%+ maintenance factor, rated lamp life of 30,000 hours or more, low mercury (under 3.7 mg), minimum 3 year warranty from date of install.
 - T-5 HO lamps shall meet or exceed the following requirements: 800 series phosphor, 80+ CRI rating, 93%+ maintenance factor, rated lamp life of 25,000 hours or more, low mercury (under 1.5 mg), and minimum 3 year warranty from date of install.
- Compact Fluorescent Lamps
 - Acceptable Manufacturers: Philips, General Electric, Sylvania, TCP, Harmony or pre-approved equivalent.
 - General Requirements: Compact fluorescent lamps shall be a minimum 80+ CRI rating, rated lamp life of 8,000 hours or more, minimum 1 year warranty from date of install.
- Cold Cathode Lamps: Make, manufacturer and manufacturer data shall be pre-approved prior to installation. This same data shall accompany the rebate application when submitted. Minimum 3 year warranty from date of install.
- Induction Lamps: Make, manufacturer and manufacturer data shall be pre-approved prior to installation. This same data shall accompany the custom rebate application when submitted. Minimum 7 year warranty from date of install.
- LED Lamps: Make, manufacturer and manufacturer data shall be pre-approved prior to installation. This same data shall accompany the custom rebate application when submitted. Minimum 7 year warranty from date of install.
- LED Traffic Signals: Shall meet MDOT, County and City specifications. Make, manufacturer and manufacturer data shall be pre-approved prior to installation. This same data shall accompany the rebate application when submitted. Minimum 7 year warranty from date of install.
- Ballasts
 - Acceptable Manufacturers: Philips/Advance, General Electric, Sylvania/Osram, Universal/MagneTek or pre-approved equivalent.
 - Linear Fluorescent Instant Start: Shall only be used when lamps will operate more than

8 hours per start. Ballasts shall be electronic, constant current, provide parallel lamp operation, multi-voltage (110v-277v) or dual voltage 120/277V, have auto lamps re-strike feature, harmonic distortion of less than 15%, power factor greater than .95, design to minimize/eliminate lamp striation, designed to operate with reduced wattage lamps, have class A sound rating, minimum 5 year warranty.

- Linear Fluorescent Programmed Start: Shall be used when lamps will operate less than 8 hours per start. Ballasts shall be electronic, constant current, provide parallel lamp operation, multi-voltage (110v-277v) or dual voltage 120/277V, have auto lamp re-strike feature, harmonic distortion of less than 15%, power factor greater than 95%, design to minimize/eliminate lamp striation, designed to operate with reduced wattage lamps, have class A sound rating, minimum 5 year warranty.
- Linear Fluorescent Dimmable: Shall be programmed start, shall allow dimming from full output to 5% light output without striation, ballast factor shall be less than 1.0 at full light output and .05 at minimum light output, shall strike lamps at any output setting, have auto lamp re-strike feature, harmonic distortion of less than 15% at all settings, power factor greater than .95, have class A sound rating, minimum 5 year warranty.
- Remote Ballasted Compact Fluorescent: Ballasts shall be electronic, programmed start, constant current, multi-voltage (110v-300v) or dual voltage 120/277V, have auto lamp re-strike feature, harmonic distortion of less than 15%, design to minimize/eliminate lamp striation, have class A sound rating, minimum 3 year warranty.
- Dimmable Remote Ballasted Compact Fluorescent: Shall be programmed start, shall allow dimming from full output to 5% light output without striation, ballast factor shall be less than 1.0 at full light output and .05 at minimum light output, shall strike lamps at any output setting, have auto lamp re-strike feature, harmonic distortion of less than 15% at all settings, power factor greater than 95%, have class A sound rating, minimum 3 year warranty.

Lighting Control

Occupancy Sensors

- Acceptable Manufacturers: Watt Stopper, Hubbell, Lithonia, General Electric, Leviton or pre-approved equivalent.
- General: All devices shall be passive infrared/ultrasonic dual technology sensors with adjustable time delay, adjustable sensitivity, compatible with electronic ballasts and PL ballasts.
- Wall Switch: Provide sensors that are dual voltage (120/277), 800/1200 watt minimum capacity, manual or automatic "on" capability, no minimum load requirement, 180° coverage pattern suitable for a minimum of a 300 sq ft or greater as space requirements dictate, suitable for mounting in a single gang box.
- Line Voltage Wall Mounted: Provide sensors that are dual voltage (120/277), 800/1200 watt minimum capacity, capable of accepting manual "on" input, coverage pattern suitable for 1000 sq ft or greater as space requirements dictate.

- Low Voltage Wall Mounted: Provide sensors that are low voltage (24 VDC/VAC) suitable for relay interface, isolated SPDT output relay with contacts rated for 1 amp, capable of accepting manual “on” input, coverage pattern suitable for a minimum of a 1000 sq ft or greater as space requirements dictate.
- Line Voltage Ceiling Mounted: Provide sensors that are dual voltage (120/277), 800/1200 watt minimum capacity, capable of accepting manual “on” input, 360° coverage pattern suitable for 1000 sq ft or greater as space requirements dictate.
- Low Voltage Ceiling Mounted: Provide sensors that are low voltage (24 VDC/VAC) suitable for relay interface, isolated SPDT output relay with contacts rated for 1 amp, capable of accepting manual “on” input, 360° coverage pattern suitable for a minimum of a 1000 sq ft or greater as space requirements dictate.
- Accessories
 - Power Supplies: Provide units that are fully enclosed, plenum rated, 300 volt insulation on low voltage leads, 600 volt insulation on line voltage leads,
 - Relays: Provide units that are fully enclosed, plenum rated, 300 volt insulation on low voltage leads, 600 volt insulation on line voltage leads, minimum of 2 output contacts rated for 20 amps 120/277 volts, 2 isolated NO/NC low voltage outputs rated for 1 amp at 24 VDC/VAC.

Daylight Sensing Systems

- Acceptable Manufacturers: Watt Stopper, Hubbell, Lithonia or pre-approved equivalent.
- General: Systems can be automatic dimming or automatic “On/Off” controlled systems. Systems shall be supplied complete with all control modules, dimming modules as required, relays, photocells and power packs. Provide units that are fully enclosed, plenum rated where used above ceilings, 300 volt insulation on low voltage leads, 600 volt insulation on line voltage leads.

Motors

- Approved Manufacturers: Allis-Chalmers Corp.; Baldor Electric Co.; Century Electric Div.; General Electric Co.; Louis Allis Div.; Marathon Electric Mfg. Corp.; Reliance Electric Co.; Lincoln, Westinghouse Electric Corp. or pre-approved equivalent.
- General Description: Motors shall operate satisfactorily with voltage variation of $\pm 10\%$, be dynamically balanced, operate without failure for two (2) hours at 104° F, rated for not less than 5 starts per hour, have a 1.15 service factor or better, utilize class B insulation or better, be capable of withstanding 20 seconds of stall at six (6) times rated current, be guarded where exposed to contact by employees/building occupants, contain built-in thermal overload protection, have a sound rating of “Quiet” with maximum noise levels in compliance with NEMA MG 1-12.49, be rated for the environmental conditions in which it will be applied.

- Efficiency Ratings: Motors 1 hp and above shall be ultra high efficiency type with energy efficiency above 88.5%. Motors 5 hp and above shall have a power factor above 95% or provide power factor correction to maintain a 95% minimum power factor.
- VFD Applications: Motors driven by variable frequency drives shall be inverter duty rated.
- Bearings: Shall be pre-lubricated steel ball or roller bearing type for motors less than 1 hp. and sleeve type for motors 1 horsepower and greater. Shall have a minimum rated life span of L-10 for 200,000 hours of operation. Housings shall have grease openings for simultaneous adding of new grease while purging of old. Opening plugs shall be corrosion resistant and easily accessible. Provide lube opening extensions as required.

Variable Frequency Drives

- Approved Manufacturers: ABB, Graham, Danfoss, Eaton Corporation, GE, Allen-Bradley, Square D, Toshiba or pre-approved equivalent.
- Description: NEMA ICS 2, IGBT, PWM, VFD arranged to provide variable speed control of NEMA MG 1, Design B, 3-phase induction motors by adjusting output voltage and frequency. Provide unit suitable for operation of both standard and premium efficiency motors as defined by NEMA MG 1.
- Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range
- Operating Requirements: Input ac voltage tolerance of 208V (+/- 5%) or 480V (+/- 5%). Input frequency tolerance of 50/60 Hz, plus or minus 6 percent. Minimum efficiency of 96 percent at 60 Hz, full load. Minimum Primary-Side Power Factor of 95%. The overload capability shall be 1.1 times the base load current for 60 seconds and 2.0 times the base load current for 3 seconds. Starting torque shall be 100 percent of rated torque. Speed regulation shall be +/- 1%. Isolated control interface to allow controller to follow control signal over an 11:1 speed range. Minimum speed shall be adjustable from 5% to 25% of maximum rpm. Maximum speed shall be adjustable from 80% to 100% of maximum rpm. Acceleration/Deceleration shall adjust from 2 minutes to a minimum of 22 seconds. Current limiting shall adjust from 50% to 110% percent of maximum rating.
- Self-Protection and Reliability Features: Unit shall have under and over-voltage trips, over-temperature trip, overload trip, over-current trip, motor overload relay, notch filtering, line-to-line and line-to-ground over-current trips, loss-of-phase/reverse phase protection, short-circuit protection, motor over-temperature fault.
- Automatic Reset/Restart: Unit shall attempt three restarts after a controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Unit shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- Power-Interruption Protection: Unit shall not allow the motor to be re-energized after a power interruption until motor has stopped.

- Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- Control: Unit shall have microprocessor based control indicating VFD operational parameters.

Power Factor Capacitors

- Approved Manufacturers: General Electric, ITE, Sprague or pre-approved equivalent.
- General: Capacitors shall be industrial grade three phase, 60 cycle, voltage as required. Unit shall be capable of operation in ambient temperatures between -40° C to +46° C. Capacitor assembly shall be made up of single or multiple capacitor units. Capacitor units shall consist of a three phase capacitor, hermetically sealed welded case, internal discharge resistors, dust proof or weatherproof enclosure. Protection shall be provided for capacitor in excess of 27.5 kVAR. Capacitor protection shall include individual indicating type current limiting fuses with an interrupting capacity of 200,000 amperes and time-current characteristics designed to minimize the chance of container rupture, pop-up button, indicating light or similar blown fuse indication.

Cooling Equipment

- Air-Cooled Condensing Units
 - Approved Manufacturers
 - Residential Grade Units: Trane, Heil, Carrier, Lennox or pre-approved equivalent.
 - Commercial Grade Units: Dunham-Bush, McQuay, Trane, York or pre-approved equivalent.
 - General: Provide package residential grade air-cooled condensing units in the one to five ton range with a minimum SEER rating of 14.0. Provide commercial grade air-cooled condensing units for applications above 5 tons with a minimum EER rating of 10.3. Units shall be rated for outdoor applications.
 - Unit Casing: Provide a unit with a heavy duty galvanized steel cabinet, weather resistant urethane paint finish, quick release access panels, control and compressor compartment, removable top panel.
 - Compressor(s): Provide a unit with a fully hermetic direct drive scroll, refrigerant gas cooled, force feed lubrication system, solid state motor protection, suction and discharge valves, vibration isolating compressor mounts, R-22 refrigerant warranty.
 - Condenser Coil: Provide a unit with seamless copper or aluminum tubes mechanically bonded to aluminum fins, internally riffling tubes, integral sub-cooling circuits.
 - Condenser Fans and Motors: Provide a unit with a direct drive propeller type fans, dynamically and statically balanced, rigid mounting, heavy wire outlet grille, inherent thermal overload motor protection, permanently lubricated bearings, rain shield motor

protection, individual motor for each fan.

- Controls – Residential Applications: Control systems shall be contained in a weatherproof enclosure and shall include at a minimum a high pressure cutout, low pressure control, internal high winding temperature thermostats, compressor anti-cycle timer, pre-wired control circuits, field installed liquid line filter dryer, single point power connection, low ambient control.
- Controls – Commercial Applications: Control systems shall be contained in a weatherproof enclosure and shall include at a minimum a high pressure cutout, low pressure control, internal high winding temperature thermostats, compressor anti-cycle timer, pre-wired control circuits, field installed liquid line solenoid valve, single point power connection, low ambient control.
- Warranty: Compressors shall carry a (5) warranty. All other system components shall carry a (3) year warranty.
- Packaged Air Conditioning Units
 - Approved Manufacturers: Trane, Carrier, McQuay, York or pre-approved equivalent.
 - General: Provide a self-contained, factory-assembled and wired unit consisting of cabinet, compressor, evaporator fan, evaporator coil, air filters, controls, full charged of refrigerant and oil, drain pans, filter sections, plenum sections, powered exhaust economizer section, exterior louver and wall sleeve. Unit components shall meet the minimum requirements outlined below. Provide units with minimum SEER rating of 14.0 for units smaller than 5 tons, 10.3 EER for units between 5 and 10 tons and 9.7 EER for units over 10 tons.
 - Cabinet: Shall consist of structural-steel frame with galvanized steel panels, baked-enamel finish, access doors or panels, Minimum 1-inch thick insulation, 1 ½ Lb/Ft 3 density fiberglass neoprene coated acoustic duct liner on cabinet interior and control panel, Galvanized steel drain pan with corrosion-resistant coating.
 - Evaporator Fan: Shall consist of statically and dynamically balanced centrifugal fan, belt drive with fan mounted on permanently lubricated bearings cast-iron or steel dynamically balanced sheaves bored to fit shafts, variable and adjustable pitch motor sheave, internal vibration isolation.
 - Compressor: Units shall be reciprocating design hermetically sealed, 3600 rpm maximum, resiliently mounted with positive lubrication and internal motor protection.
 - Direct Expansion Coil: Seamless copper tubes expanded into aluminum fins.
 - Refrigeration Circuit: A separate circuit for each compressor, with externally equalized thermal-expansion valve, filter-dryer, and charging valves.
 - Remote Air-Cooled Condenser: Unit shall be Factory assembled and tested; consisting of condenser coil, fans and motors, and operating controls; suitable for exterior mounting. Condenser coil shall be aluminum-fin copper tube with integral sub-cooler leak tested to 425 psig. Condenser fans shall be direct-drive propeller type with permanently lubricated motors with built-in thermal-overload protection.

- Refrigerant Line Kits: Annealed-copper suction and liquid lines that are factory cleaned, dried, pressurized, and sealed; insulated suction line; flared fittings at evaporator end, no fitting at condenser end; and service valves for both suction and liquid lines.
- Low Ambient Control: Cycles fans and modulates condenser fan damper assembly to permit operation down to 0° F.
- Coils: Provide common or individual casing for heating and cooling. Design internal structure of coil section to allow for easy removal of coils and provide suitable baffles to assure no air bypass around coils. Provide condensate pans and drain connections to cooling coil sections of sufficient size to contain and remove coil condensate.
- Cooling Coils: Shall be mounted in the unit in manner permitting easy removal, inspection and cleaning. Primary surface shall be Round seamless 1/2" or 5/8" copper tube with brazed joints. Secondary surface shall be rippled aluminum fins with the tube mechanically expanded into the fins. The casing shall be galvanized 16-gauge steel with reinforced mounting flange, reinforced side plates, copper headers, steel pipe connectors, vent at high point, drain at low point, intertwined circuits, coils shall be rated for operating conditions of 250 PSIG and 300° F.
- Air Filters: Disposable 2-inches thick glass-fiber with pleated panel filters.
- Accessories
 - Exterior Louvers and Wall Sleeve: An exterior, weather resistant louver shall be supplied. Louver shall be heavy 16 gauge galvanized steel with a powder coat painted finish. Louver shall be lined with 1/2" bird screen mesh. Louver size and design shall be matched to the model to provide ventilation air intake & condenser air intake or exhaust if applicable.
 - Plenums and Stand offs: 4 sided, non-insulated cosmetic cover shall be included with each unit. Cover shall be constructed of heavy 18-gauge steel with powder coat painted finish. A rear standoff shall be included. Standoff shall be constructed of heavy 18 gauge steel with 1" (25.4 mm) flange for unit mounting and painted in textured powder coat finish.
 - Attenuator: Provide units with a manufactures return grille silencer that meets the following attenuation:

INSERTION LOSS (DB) AT FREQUENCY (HZ)							
63	125	250	500	1000	2000	4000	8000
3	14	15	19	29	27	22	20

- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Warranty: Compressors shall carry a (5) warranty. All other system components shall

carry a (3) year warranty.

- Centrifugal Water Chillers
 - Acceptable Manufacturers: Carrier Corporation, McQuay International, Trane, York or pre-approved equivalent.
 - General Requirements:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Unit shall comprise a single-stage or multi-stage, variable displacement, centrifugal type compressor, either an oil lubrication system or oil free technology, complete drive assembly, seals, motor, complete vibration balancing, configured for easy accessibility for inspection and service.
 - Compressor Motor: Unit shall be factory mounted, balanced, suitable for environment in which it is installed, provided with motor and bearing temperature monitoring, internal electric heater as required.
 - Multi Stage Systems: Systems shall be provided with interstaged economizers.
 - Capacity Control: Modulating, variable inlet guide vane assembly with hot gas bypass, configure to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
 - Refrigerant System: Provide R123 or R134a Class A1 or B1 refrigerant, flow control device, rupture disc pressure relief device for R123 systems, spring loaded pressure relief valve for R134a systems, refrigerant isolation system, purge system and positive pressure system.
 - Evaporator: Shall be shell and tube design, tubes to be replaceable from either end of unit, shell to be constructed of carbon steel rolled plates with seamless pipe, visual verification system for liquid refrigerant, cast iron or carbon steel water box arranged to provide inspection and cleaning from either end furnished with factory installed temperature sensor and corrosion protection system.
 - Standard Condenser/Heat Reclaim Condenser: Shall be shell and tube design, tubes to be replaceable from either end on unit, carbon steel rolled plates with seamless pipe, visual verification system for liquid refrigerant, cast iron or carbon steel water box arranged to provide inspection and cleaning from either end furnished with factory installed temperature sensor and corrosion protection system.
 - Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factory installed insulation over all cold surfaces of chiller.
 - Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.

- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection, power loss protection. VFD's shall meet the requirements of the Variable Frequency Drive section of this guideline.
 - Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
 - Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
 - Tool Kit: Provide factory tool kit with necessary tools required for routine maintenance of chiller components.
 - Efficiency: Unit shall be rated at a minimum of 0.65 kW/ton or as required to meet RPU minimum rebate requirements.
 - Warranty: Provide 5 year parts and labor warranty from date of final completion.
- Rotary Screw Water Chillers
 - Acceptable Manufacturers: Carrier Corporation, McQuay International, Trane, York or pre-approved equivalent.
 - General Requirements for Packaged Water Cooled Single Compressor Systems:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, lubrication system, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Unit shall be hermetically sealed, positive displacement, casing shall be precision machined for minimum clearance around periphery rotors, complete sealed drive assembly with no wearing parts, complete vibration balancing, configured for easy accessibility for inspection and service, .
 - Compressor Motor: Unit shall be factory mounted, balanced, suitable for environment in which it is installed, provided with motor and bearing temperature monitoring, internal electric heater as required.
 - Capacity Control: Modulating, slide valve assembly or port unloaders, variable frequency drive (if applicable), hot gas bypass (if applicable), configure to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
 - Refrigerant System: Provide R22 or R134a Class A1 refrigerant, flow control device, spring loaded dual valve pressure relief device for each heat exchange. Provide service valve, positive isolation shutoff valves in the discharge line and refrigerant liquid level line.

- Evaporator: Shall be shell and tube design, shell to be separate from condenser, constructed of carbon steel rolled plates with seamless pipe, visual verification system for liquid refrigerant. Tubes shall be copper or copper alloy based, individually replaceable, mechanically expanded into sheets. End tube sheets shall be continuously welded, drilled and reamed to provide positive seal between tubes and shell. Intermediate tube sheets shall be spaced along the length of tube, spacing of tubes shall eliminate vibration and contact between tubes. Water box shall be cast iron or carbon steel, arranged to provide inspection and cleaning from either end furnished with factory installed temperature sensor and corrosion protection.
- Condenser/Heat Reclaim Condenser: Shall be shell and tube design, carbon steel rolled plates with seamless pipe with visual verification system for liquid refrigerant. End tubes to be replaceable from either end on unit, end tube sheets shall be continuously welded, drilled and reamed to accommodate tubes with positive seal between fluid and refrigerant. Intermediate tube sheets shall be installed in shell and spaced along length of tube as required to eliminate vibration and prevent contact between tubes. Water box shall be cast iron or carbon steel, arranged to provide inspection and cleaning from either end, furnished with factory installed temperature sensor and corrosion protection system,
- Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factory installed insulation over all cold surfaces of chiller.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection, power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- General Requirements for Packaged Water Cooled Multi-Compressor Systems:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, lubrication system, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Unit shall be hermetically sealed, positive displacement, casing shall be precision machined for minimum clearance around periphery rotors, complete vibration balancing, oil lubrication system, configured for easy accessibility for inspection and service, .

- Compressor Motor: Unit shall be factory mounted, hermetically sealed, refrigerant cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
- Capacity Control: On-Off compressor cycling and modulating, slide valve assembly or port unloaders combined with hot gas bypass (if applicable), configure to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
- Refrigerant System: Provide R22 or R134a Class A1 refrigerant. Each refrigerant circuit shall include expansion valve, refrigerant charging connections, hot gas muffler, compressor and discharge shutoff valve, filter dryer, sight glass with moisture indicator and liquid line solenoid shutoff valve. Provide spring loaded pressure relief valve, positive shutoff isolation valve in compressor discharge line and refrigerant liquid line.
- Evaporator: Shall be shell and tube design direct expansion type or flooded type, shell to be constructed of carbon steel. Shell head shall be removable carbon steel with multipass baffles and located at each end of the tube bundle. Fluid nozzles shall be terminated with mechanical coupling or flanged end connections. Tubes shall be individually replaceable, constructed of copper or copper alloy with enhanced fin design, expanded into tube sheets.
- Condenser: Shall be shell and tube design or with integral condenser. Provide positive sub-cooling of liquid refrigerant. Shell to be constructed of carbon steel. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets. Provide pressure relief device, purge cock and liquid line shutoff valve.
- Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factor installed insulation over all cold surfaces of chiller.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection, power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- General Requirements for Packaged Air Cooled Chiller:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, lubrication system,

control devices, control wiring, microprocessor based operator interface and all associated wiring.

- Compressor: Unit shall be hermetically sealed, positive displacement, casing shall be precision machined for minimum clearance around periphery rotors, complete vibration balancing, oil lubrication system, configured for easy accessibility for inspection and service.
- Compressor Motor: Unit shall be factory mounted, hermetically sealed, cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
- Capacity Control: On-Off compressor cycling and modulating, slide valve assembly or port unloaders combined with hot gas bypass (if applicable), configure to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
- Refrigerant System: Provide R22 or R134a Class A1 refrigerant. Each refrigerant circuit shall include expansion valve, refrigerant charging connections, hot gas muffler, compressor and discharge shutoff valves, filter dryer, sight glass with moisture indicator and liquid line solenoid shutoff valve. Provide spring loaded pressure relief valve, positive shutoff isolation valve in compressor discharge line and refrigerant liquid line.
- Evaporator: Shall be shell and tube design direct expansion type or flooded type, shell to be constructed of carbon steel. Shell head shall be removable carbon steel with multipass baffles and located at each end of the tube bundle. Fluid nozzles shall be terminated with mechanical coupling or flanged end connections. Tubes shall be individually replaceable, constructed of copper or copper alloy with enhanced fin design, expanded into tube sheets. Unit shall have a heater to protect evaporator down to minus 20° F.
- Air Cooled Condenser: Shall be Plate fin coil with integral sub-cooling on each circuit, rated at 450 psig. Coil casing shall be constructed of stainless steel. Coils shall be copper or copper alloy tubes mechanically bonded to the fins with baked epoxy corrosion resistant coating applied after fabrication. Provide unit with hail guards. Fans shall be direct drive propeller type properly balanced. Provide high efficiency fan motor with housing suitable for the environment in which it is installed.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection and power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.

- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- Tool Kit: Provide factory tool kit with necessary tools required for routine maintenance of chiller components.
- Efficiency: Unit shall be rated at a minimum of 0.65 kW/ton or as required to meet RPU minimum rebate requirements.
- Warranty: Provide 5 year parts and labor warranty from date of final completion.
- Reciprocating Water Chillers
 - Acceptable Manufacturers: Carrier Corporation, McQuay International, Trane, York or pre-approved equivalent.
 - General Requirements Packaged Water Cooled Water Chillers:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Positive displacement direct drive semihermetically sealed, suction and discharge service valves, crankcase oil heater, suction strainer. Provide oil lubrication system and complete vibration balancing/isolation. Unit shall be configured for easy accessibility for inspection and service.
 - Compressor Motor: Unit shall be factory mounted, hermetically sealed, refrigerant cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
 - Capacity Control: Combination of cylinder unloading, on-off compressor cycling and hot gas bypass. Compressor shall be capable of running at part load conditions and shall be capable of continuous operation at lowest step of unloading. Configure unit to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
 - Refrigerant System: Provide R22 or R134a Class A1 refrigerant. Each refrigerant circuit shall include expansion valve, refrigerant charging connections, hot gas muffler, compressor and discharge shutoff valves, filter dryer, sight glass with moisture indicator and liquid line solenoid shutoff valve. Provide spring loaded pressure relief valve, positive shutoff isolation valve in compressor discharge line and refrigerant liquid line.
 - Evaporator: Shall be shell and tube design or brazed plate design.
 - Shell and Tube: Direct expansion type constructed of carbon steel. Shell heads shall be removable carbon steel heads with multipass baffles designed to ensure positive oil pressure return. Fluid nozzles shall be located along the side of the shell and terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets.

- Brazed Plate: Direct expansion, single pass, 316 stainless steel construction. Fluid nozzles shall be terminated with mechanical coupling end connections.
- Condenser: Shall be shell and tube or brazed plate design.
 - Shell and Tube: Shell and tube design with positive sub-cooling of liquid refrigerant. Shell shall be carbon steel construction. Water box shall be removable of carbon steel construction, located at each end of fluid bundle with nozzles terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets. Provide pressure relief device, purge cock and liquid line shutoff valve.
 - Brazed Plate: Single pass design providing positive sub-cooling of liquid refrigerant and constructed of 316 stainless steel. Fluid nozzles shall be terminated with mechanical coupling end connections. Provide liquid line shutoff valve.
- Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factor installed insulation over all cold surfaces of chiller.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection and power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- General Requirements Packaged Air Cooled Water Chillers:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Positive displacement direct drive semihermetically sealed, suction and discharge service valves, crankcase oil heater and suction strainer. Provide oil lubrication system and complete vibration balancing/isolation. Unit shall be configured for easy accessibility for inspection and service.
 - Compressor Motor: Unit shall be factory mounted, hermetically sealed, refrigerant cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
 - Capacity Control: Combination of cylinder unloading, on-off compressor cycling and

hot gas bypass. Compressor shall be capable of running at part load conditions and shall be capable of continuous operation at lowest step of unloading. Configure unit to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.

- Refrigerant System: Provide R22 or R134a Class A1 refrigerant. Each refrigerant circuit shall include expansion valve, refrigerant charging connections, hot gas muffler, compressor and discharge shutoff valves, filter dryer, sight glass with moisture indicator and liquid line solenoid shutoff valve. Provide spring loaded pressure relief valve, positive shutoff isolation valve in compressor discharge line and refrigerant liquid line.
- Evaporator: Shall be shell and tube design or brazed plate design.
 - Shell and Tube: Direct expansion type constructed of carbon steel. Shell heads shall be removable carbon steel heads with multipass baffles designed to ensure positive oil pressure return. Fluid nozzles shall be located along the side of the shell and terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets.
 - Brazed Plate: Direct expansion, single pass, 316 stainless steel construction. Fluid nozzles shall be terminated with mechanical coupling end connections.
- Condenser: Shall be shell and tube or brazed plate design.
 - Shell and Tube: Shell and tube design with positive sub-cooling of liquid refrigerant. Shell shall be carbon steel construction. Water box shall be removable of carbon steel construction, located at each end of fluid bundle with nozzles terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets. Provide pressure relief device, purge cock and liquid line shutoff valve.
 - Brazed Plate: Single pass design providing positive sub-cooling of liquid refrigerant and constructed of 316 stainless steel. Fluid nozzles shall be terminated with mechanical coupling end connections. Provide liquid line shutoff valve.
- Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factor installed insulation over all cold surfaces of chiller.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection and power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security

access.

- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- Tool Kit: Provide factory tool kit with necessary tools required for routine maintenance of chiller components.
- Efficiency: Unit shall be rated at a minimum of 0.65 kW/ton or as required to meet RPU minimum rebate requirements.
- Warranty: Provide 5 year parts and labor warranty from date of final completion.
- Scroll Water Chillers
 - Acceptable Manufacturers: Carrier Corporation, McQuay International, Trane, York or pre-approved equivalent.
 - General Requirements Packaged Water Cooled Water Chillers:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Positive displacement direct drive hermetically sealed, suction and discharge service valves, crankcase oil heater, suction strainer. Provide oil lubrication system and complete vibration balancing/isolation. Unit shall be configured for easy accessibility for inspection and service.
 - Compressor Motor: Unit shall be factory mounted, hermetically sealed, refrigerant cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
 - Capacity Control: On-off compressor cycling and hot gas bypass. Configure unit to achieve most energy efficient operation possible.
 - Refrigerant System: Provide R22 or R134a Class A1 refrigerant. Each refrigerant circuit shall include expansion valve, refrigerant charging connections, hot gas muffler, compressor and discharge shutoff valves, filter dryer, sight glass with moisture indicator and liquid line solenoid shutoff valve. Provide spring loaded pressure relief valve, positive shutoff isolation valve in compressor discharge line and refrigerant liquid line.
 - Evaporator: Shall be shell and tube design or brazed plate design.
 - Shell and Tube: Direct expansion type constructed of carbon steel. Shell heads shall be removable carbon steel heads with multipass baffles designed to ensure positive oil pressure return. Fluid nozzles shall be located along the side of the shell and terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets.
 - Brazed Plate: Direct expansion, single pass, 316 stainless steel construction. Fluid nozzles shall be terminated with mechanical coupling end connections.

- Condenser: Shell and tube design with positive sub-cooling of liquid refrigerant. Shell shall be carbon steel construction. Water box shall be removable of carbon steel construction, located at each end of fluid bundle with nozzles terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets. Provide pressure relief device, purge cock and liquid line shutoff valve.
 - Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factor installed insulation over all cold surfaces of chiller.
 - Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
 - Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection and power loss protection.
 - Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
 - Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- General Requirements Packaged Air Cooled Water Chillers:
 - Manufactured Unit: Unit shall be factory assembled and tested complete with compressor, evaporator, condenser, motors, motors controllers, control devices, control wiring, microprocessor based operator interface and all associated wiring.
 - Compressor: Positive displacement direct drive semihermetically sealed, suction and discharge service valves, crankcase oil heater and suction strainer. Provide oil lubrication system, complete vibration balancing/isolation. Unit shall be configured for easy accessibility for inspection and service.
 - Compressor Motor: Unit shall be factory mounted, hermetically sealed, refrigerant cooled, balanced, suitable for environment in which it is installed with integral thermal overload protection on each phase.
 - Capacity Control: Combination of cylinder unloading, on-off compressor cycling and hot gas bypass. Compressor shall be capable of running at part load conditions and shall be capable of continuous operation at lowest step of unloading. Configure unit to achieve most energy efficient operation possible, operating range shall be at least 100% to 10% of rated capacity.
 - Refrigerant System: Provide R407a or R410c Class A1. Each circuit shall include an expansion valve, refrigerant charging connections, a hot gas muffler, compressor suction and discharge valve, filter dryer, sight glass with moisture indication, liquid line solenoid valve and insulated suction line. Provide positive shutoff isolation

valves in the compressor discharge line and the refrigerant liquid line.

- Evaporator: Shall be shell and tube design or brazed plate design.
 - Shell and Tube: Direct expansion type constructed of carbon steel. Shell heads shall be removable carbon steel heads with multipass baffles designed to ensure positive oil pressure return. Fluid nozzles shall be located along the side of the shell and terminated with mechanical coupling end connections. Tubes shall be individually replaceable copper or copper alloy tubes with enhanced fin design expanded into sheets.
 - Brazed Plate: Direct expansion, single pass, 316 stainless steel construction. Fluid nozzles shall be terminated with mechanical coupling end connections.
 - Heater: Provide heating system with integral controls design to protect evaporator to minus 20° F.
- Condenser: Shall be plate fin with integral sub-cooling on each circuit, rated to 450 psig. Fans shall be direct drive propeller type properly balanced. Fan motors shall be high efficiency with enclosure suitable for the environment for which it is installed. Provide lubricated bearings, integral overcurrent and thermal protection.
- Insulation: Shall be closed cell, flexible elastomeric thermal insulation 1 ½" thick, provide factory installed insulation over all cold surfaces of chiller.
- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirements but not less than 42K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Motor Controller: Type as required by application, externally operated disconnect, digital monitoring system, manual pushbutton over-ride capability, phase failure protection, phase reversal protection and power loss protection.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, with trending capabilities and security access.
- Sound Barrier: Provide as necessary to reduce noise level below 80 dB.
- Tool Kit: Provide factory tool kit with necessary tools required for routine maintenance of chiller components.
- Efficiency: Unit shall be rated at a minimum of 0.65 kW/ton or as required to meet RPU minimum rebate requirements.
- Warranty: Provide 5 year parts and labor warranty from date of final completion.

Geo-Thermal Ground Source Heat Pump Systems

- Acceptable Manufacturers: Geo-Comfort, WaterFurnace, Hydron Module, Ice Kube Systems, Econar, or pre-approved equivalent.

- General Requirements: These minimum requirements shall apply to: water to air, water to refrigeration and water to water systems. In general the systems shall be designed and installed in a manner that complies with the following:
 - Design Requirements
 - Extended range capability to include entering liquid temperature down to 30° F in heating mode and up to 100° F in cooling mode. A maximum water-side head loss of 12 ft of water at 3 gpm per nominal ton of cooling. Water heating units shall have a minimum EER of 14.1 and/or a minimum COP of 3.3 with 50° F liquid entering the evaporator and 100° F water entering the condenser.
 - Equipment/Installation Requirements:
 - Water-to-Air and Water-to-Water Heat Pumps: Units shall be reverse cycle heating/cooling type, contain sealed refrigeration circuits, hermetically sealed motor-compressor, bidirectional thermostatic expansion valve, finned tube air to refrigerant heat exchanger or coaxial tube water to refrigerant heat exchanger, desuperheater coil (as required), reversing valve and service ports.
 - Compressors shall be high efficiency scroll type designed for heat pump duty, isolated for vibration, provided with thermal and overload protection on each phase.
 - Coil shall be copper tube construction with aluminum fins, enamel coated, sized for low face velocity.
 - Water to refrigerant heat exchanger shall be designed for low water pressure drop, copper or copper based alloy inner tube and steel outer tube. Provide thermostatic expansion valve that operates bi-directionally without check valves. All lines shall be insulated.
 - Fan motor assembly shall be direct drive centrifugal style with dynamically balanced wheel, designed for low velocity operation, configured to provide ease of maintenance. Fan motor shall be high efficiency, multi speed or VFD rated, permanently lubricated, ball bearing type with integral thermal and overload protection. Enclosure shall be suitable for the environment for which it is installed
 - Evaporative Fluid Coolers: Shall be fluid cooling coil type, constructed of aluminum alloy frames, headers, tubing, fins and chute. Pan shall be constructed of non-corrosive material such as fiberglass or stainless steel. Unit shall have a post assembly powder coat paint finish. Fans shall be direct drive propeller type properly balanced. Fan motors shall be high efficiency with enclosure suitable for the environment for which it is installed, multi speed or VFD rated as required, permanently lubricated, ball bearing type with integral thermal and overload protection.
 - Ground Loop Piping System: Shall be comprised of High Density Polyethylene (types PE 3408 SDR 11 or PE 3408 SCH 40 as required). Electric fusion is the only acceptable means to join the pipe. A glycol water mix shall be installed in the ground loop. The percent glycol shall be high enough to protect from gelling or freezing. The system should completely purge all air. Provide all backfilling and grouting as

required in accordance with IGSHA guidelines. Vertical wells if installed shall be by a state of Minnesota approved drilling contractor.

- Electrical: All electrical components and wiring shall be factory installed and tested, single point field power connection, disconnect minimum withstand rating shall be as required to meet system requirement but not less than 65K amps, clearly labeled and terminated control wiring, system power factor shall be a minimum of 95%.
- Controls: Shall be stand alone microprocessor based with nonvolatile memory, utilize an open communication architecture, graphic display, real time data, automatic reset for non-critical system parameters, manual reset for critical system parameters, trending, security access.
- Motor Controller: Type as required by application, externally operated disconnect, digitally monitored from the control system with manual over-ride capability.
- Documentation Requirements: In addition to the documentation requirements listed under the General ESP Requirements section provide the following:
 - Submit documentation from the equipment manufacturer stating that the contractor has attended factory training and is a factory certified installer of the their equipment.
 - Submit the procedures intended to be utilized for fusing and installing the HDPE pipe.
 - Provide documentation for the proper mix of water/glycol as determined by the glycol manufacturer.
- Warranty: Provide 5 years parts and labor warranty from date of final completion.

Document Contributors and Sources

The following manufacturers, manufacturer's representatives and professional consultants contributed technical specifications, technical information and professional expertise to the development of these specifications.

Manufacturers:

ABB
Carrier Corporation
Cutler Hammer
Dan Foss Inc.
General Electric Company
Ice Kube
Lincoln Motors
Philips Lighting Company
Sensor Switch
Trane
WaterFurnace
Watt Saver/Legrand

Consultants:

Earth Energy and Ice, LLC
EESCO United Electric
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