HVAC Guide Specifications
Variable Speed Screw Chiller

Size Range:
٢٥٠ to ٥٥٠ Tons (٨٧٩ to ١٩٣٤ kW) Nominal

Carrier Model Number:
٢٣XRV

Part ١ — General

١,٠١ SYSTEM DESCRIPTION

A. Microprocessor-controlled liquid chiller shall use a semi-hermetic screw compressor using refrigerant HFC-١٣٤a only. Chiller refrigerant shall not have a planned phase out date.
B. If a manufacturer proposes a liquid chiller using HCFC-١٢٣ refrigerant, which has a planned phase out date, then the manufacturer shall include in the chiller price:
   ١. A vapor activated alarm system consisting of all alarms, sensors, safeties, and ventilation equipment as required by ANSI/ASHRAE Standard ١٥ Safety Code for Mechanical Refrigeration (latest edition) with the quotation. System shall be capable of responding to HCFC-١٢٣ levels of ١٠ ppm Allowable Exposure Limit (AEL).
   ٢. A free-standing refrigerant storage tank and pumpout unit shall be provided. The storage vessels shall be designed per ASME Section VIII Division ١ code with ٣٠٠ psig (٢٠٦٨ kPa) design pressure. Double relief valves per ANSI/ASHRAE ١٥, latest edition, shall be provided. The tank shall include a liquid level gage and pressure gage. The pumpout unit shall use a semi-hermetic reciprocating compressor with water-cooled condenser. Condenser water piping, ٣-phase motor power, and ١١٥-volt control power shall be installed at the jobsite by the installing contractor.
   ٣. Zero emission purge unit capable of operating even when the chiller is not operating.
   ٤. Back-up relief valve to rupture disk.
   ٥. Factory-installed chiller pressurizing system to prevent leakage of noncondensables into the chiller during shutdown periods.
   ٦. Plant room ventilation.
   ٧. Removal and disposal of refrigerant at the end of the phase out period.
   ٨. Chillers utilizing a purge unit shall include in the machine price the costs to perform the following regular maintenance procedures:
      a. Weekly: Check refrigerant charge.
      b. Quarterly: Charge purge unit dehydrator at least quarterly, more often if necessary. Clean foul gas strainer. Perform chemical analysis of oil.
      c. Annually: Clean and inspect all valves. Drain and flush purge shell. Clean orifices.

١,٠٢ QUALITY ASSURANCE

A. Chiller performance shall be rated in accordance with AHRI Standard ٥٥٠/٥٩٠, latest edition.
B. Equipment and installation shall be in compliance with ANSI/ASHRAE ١٥ (latest edition).
C. Cooler and condenser refrigerant side shall include ASME “U” stamp and nameplate certifying compliance with ASME Section VIII, Division ١ code for unfired pressure vessels.
D. A manufacturer’s data report is required to verify pressure vessel construction adherence to ASME vessel construction requirements. Form U-١ as required per ASME code rules is to be furnished to the owner. The U-١ Form must be signed by a qualified inspector, holding a National Board Commission, certifying that construction conforms to the latest ASME Code Section VIII, Div. ١ for pressure vessels. The ASME symbol “U” must also be stamped on the heat exchanger. Vessels specifically exempted from the scope of the code must come with material, test, and construction methods certification and detailed documents similar to ASME U-١; further, these must be signed by an officer of the company.
E. Chiller shall be designed and constructed to meet UL and UL of Canada requirements and have labels appropriately affixed.
F. Unit shall be manufactured in a facility registered to ISO ٩٠٠١ Manufacturing Quality Standard.
G. Each compressor assembly shall undergo a mechanical run-in test to verify vibration levels, oil pressures, and temperatures are within acceptable limits. Each compressor assembly shall be

proof tested at a minimum ٢٠٤ psig (١٤٠٧ kPa) and leak tested at ١٨٥ psig (١٢٧٦ kPa) with a tracer gas mixture.

H. Entire chiller assembly shall be proof tested at ٢٠٤ psig (١٤٠٧ kPa) and leak tested at ١٨٥ psig (١٢٧٦ kPa) with a tracer gas mixture on the refrigerant side. The leak test shall not allow any leaks greater than ٠,٥ oz per year of refrigerant. The water side of each heat exchanger shall be hydrostatically tested at ١,٣ times rated working pressure.

I. Prior to shipment, the chiller automated controls test shall be executed to check for proper wiring and ensure correct controls operation.

J. Chillers shall have factory-mounted, factory-wired and factory-tested unit-mounted variable frequency drive (VFD). Proper VFD operation shall be confirmed prior to shipment.

١,٠٣ DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled in accordance with manufacturer's instructions.

B. Unit shall be shipped with all refrigerant piping and control wiring factory-installed.

C. Unit shall be shipped charged with oil and full charge of refrigerant HFC-١٣٤a or a nitrogen holding charge as specified on the equipment schedule.

D. Unit shall be shipped with firmly attached labels that indicate name of manufacturer, chiller model number, chiller serial number, and refrigerant used.

E. If the unit is to be exported, the manufacturer shall provide sufficient protection against sea water corrosion, making the unit suitable for shipment in a standard open top ocean shipping container.

F. Chiller and starter shall be stored indoors, protected from construction dirt and moisture. Chiller shall be inspected under shipping tarps, bags, or crates to be sure water has not collected during transit. Protective shipping covers shall be kept in place until machine is ready for installation. The inside of the protective cover shall meet the following criteria:

١. Temperature is between ٤٠ F (٤,٤ C) and ١٢٠ F (٤٨,٩ C)

٢. Relative humidity is between ١٠٪ and ٨٠٪ non-condensing.

١,٠٤ WARRANTY

Warranty shall include parts and labor for one year after start-up or ١٨ months from shipment, whichever occurs first. A refrigerant warranty shall be provided for a period of ٥ years.

Part ٢ — Products

٢,٠١ EQUIPMENT

A. General:

Factory-assembled, single piece, liquid chiller shall consist of compressor, motor, VFD, lubrication system, cooler, condenser, initial oil and refrigerant operating charges, microprocessor control system, and documentation required prior to start-up.

B. Compressor:

١. One variable speed, tri-rotor screw compressor of the high performance type.

٢. Compressor and motor shall be hermetically sealed into a common assembly and arranged for easy field servicing.

٣. The compressor motor shall be accessible for servicing without removing the compressor base from the chiller. Connections to the compressor casing shall use O-rings and gaskets to reduce the occurrence of refrigerant leakage. Connections to the compressor shall be flanged or bolted for easy disassembly.

٤. Compressor bearings must have individual design life of ٥٠٠,٠٠٠ hours or greater.

٥. Compressor shall provide capacity modulation from ١٠٠٪ to ١٥٪ capacity without the use of hot gas bypass or mechanical unloaders.

٦. Compressor shall be provided with a factory-installed positive pressure lubrication system to deliver oil under pressure to bearings and rotors at all operating conditions. Lubrication system shall include:

a. Oil pump with factory-installed motor contactor with overload protection.

b. Oil pressure sensor with differential readout at main control center.

c. Oil pressure regulator.

d. Oil filter with isolation valves to allow filter change without removal of refrigerant charge.

e. Oil sump heater [١١٥ v, ٥٠ or ٦٠ Hz] controlled from unit microprocessor.

f. Oil reservoir temperature sensor with main control center digital readout.

g. All wiring to oil pump, oil heater, and controls shall be pre-wired in the factory and power shall be applied to check proper operation prior to shipment.

٧. Compressor shall be fully field serviceable. Compressors that must be removed and returned to the factory for service shall be unacceptable.

٨. Acoustical attenuation shall be provided as required, to achieve a maximum (full load or part load) sound level, measured per AHRI Standard ٥٧٥ (latest edition).

C. Motor:

١. Compressor motor shall be of the semi-hermetic, liquid refrigerant cooled, squirrel cage, induction type suitable for voltage shown on the equipment schedule.

٢. If an open (air-cooled) motor is provided, a compressor shaft seal leakage containment system shall be provided:

a. An oil reservoir shall collect oil and refrigerant that leaks past the seal.

b. A float device shall be provided to open when the reservoir is full, directing the refrigerant/oil mixture back into the compressor housing.

c. A refrigerant sensor shall be located next to the open drive seal to detect leaks.

٣. Motors shall be suitable for operation in a refrigerant atmosphere and shall be cooled by atomized refrigerant in contact with the motor windings.

٤. Motor stator shall be arranged for service or removal with only minor compressor disassembly and without removing main refrigerant piping connections.

٥. Full load operation of the motor shall not exceed nameplate rating.

٦. One motor winding temperature sensor (and one spare) shall be provided.

٧. Should mechanical contractor choose to provide a chiller with an air-cooled motor instead of the specified semi-hermetic motor, the contractor shall install additional cooling equipment to dissipate the motor heat.
The following formula applies:
Btuh = (FLkW motor) (٠,٠٥) (٣٤١٣)
Btuh = (FLkW motor) (١٧١)
and, alternately
Tons = Btuh/١٢,٠٠٠
The additional piping, valves, air-handling equipment, insulation, wiring, switchgear changes, ductwork, and coordination with other trades shall be the responsibility of the mechanical contractor. Shop drawings reflecting any changes to the design shall be included in the submittal, and incorporated into the final as-built drawings for the project.

٨. Also, if an open motor is provided, a mechanical room thermostat shall be provided and set at ١٠٤ F (٤٠ C). If this temperature is exceeded, the chillers shall shut down and an alarm signal shall be generated to the central Energy Management System (EMS) display module, prompting the service personnel to diagnose and repair the cause of the overtemperature condition. The mechanical contractor shall be responsible for all changes to the design, including coordination with temperature control, electrical and other trades. In addition, the electrical power consumption of any auxiliary ventilation and/or mechanical cooling required to maintain the mechanical room conditions stated above shall be considered in the determination of conformance to the scheduled chiller energy efficiency requirement.

D. Evaporator and Condenser:

١. Evaporator and condenser shall be of shell and tube type construction, each in separate shells. Units shall be fabricated with high-performance tubing, steel shell and tube sheets with fabricated steel waterboxes. Waterboxes shall be nozzle-in-head type with stub out nozzles having Victaulic grooves to allow for use of Victaulic couplings.

٢. Tubing shall be copper, high-efficiency type, with integral internal and external enhancement unless otherwise noted. Tubes shall be nominal ٣/٤-in. OD with nominal wall thickness of ٠,٠٢٥ in. measured at the root of the fin unless otherwise noted. Tubes shall be rolled into tube sheets and shall be individually replaceable. Tube sheet holes shall be double grooved for joint structural integrity. Intermediate support sheet spacing shall not exceed ٣٦ in. (٩١٤ mm).

٣. Waterboxes and nozzle connections shall be designed for ١٥٠ psig (١٠٣٤ kPa) minimum working pressure unless otherwise noted. Nozzles should have grooves to allow use of Victaulic couplings.

٤. The tube sheets of the cooler and condenser shall be bolted together to allow for field disassembly and reassembly.
٥. The vessel shall display an ASME nameplate that shows the pressure and temperature data and the “U” stamp for ASME Section VIII, Division ١. A re-seating pressure relief valve(s) shall be installed on each heat exchanger. If a non-reseating type is used, a backup reseating type shall be installed in series.
٦. Waterboxes shall have vents, drains, and covers to permit tube cleaning within the space shown on the drawings. A thermistor type temperature sensor with quick connects shall be factory-installed in each water nozzle.
٧. Cooler shall be designed to prevent liquid refrigerant from entering the compressor. Devices that introduce pressure losses (such as mist eliminators) shall not be acceptable because they are subject to structural failures that can result in extensive compressor damage.
٨. Tubes shall be individually replaceable from either end of the heat exchanger without affecting the strength and durability of the tube sheet and without causing leakage in adjacent tubes.
٩. The condenser shell shall include a FLASC (Flash Subcooler) which cools the condensed liquid refrigerant to a reduced temperature, thereby increasing the refrigeration cycle efficiency.

E. Refrigerant Flow Control:
To improve part load efficiency, liquid refrigerant shall be metered from the condenser to the cooler using a float-type metering valve to maintain the proper liquid level of refrigerant in the heat exchangers under both full and part load operating conditions. By maintaining a liquid seal at the float valve, bypassed hot gas from the condenser to the cooler is eliminated.

F. Controls, Safeties, and Diagnostics:
١. Controls:
a. The chiller shall be provided with a factory-installed and factory-wired microprocessor control center. The control center shall include a ١٦-line by ٤٠-character liquid crystal display, ٤ function keys, stop button, and alarm light. Other languages are available using the international language translator software.
b. All chiller and motor control monitoring shall be displayed at the chiller control panel.
c. The controls shall make use of non-volatile memory.
d. The chiller control system shall have the ability to interface and communicate directly to the building control system.
e. The default standard display screen shall simultaneously indicate the following minimum information:
١) Date and time of day
٢) ٢٤-character primary system status message
٣) ٢٤-character secondary status message
٤) Chiller operating hours
٥) Entering chilled water temperature
٦) Leaving chilled water temperature
٧) Evaporator refrigerant temperature
٨) Entering condenser water temperature
٩) Leaving condenser water temperature
١٠) Condenser refrigerant temperature
١١) Oil supply pressure
١٢) Oil sump temperature
١٣) Percent motor rated load amps (RLA)
f. In addition to the default screen, status screens shall be accessible to view the status of every point monitored by the control center including:
١) Evaporator pressure
٢) Condenser pressure
٣) Compressor speed
٤) Bearing oil supply temperature
٥) Compressor discharge temperature
٦) Motor winding temperature

٧) Number of compressor starts
٨) Control point settings
٩) Discrete output status of various devices
١٠) Variable frequency drive status
١١) Optional spare input channels
١٢) Line current and voltage for each phase
١٣) Frequency, kW, kWhr, demand kW

g. Schedule Function:
The chiller controls shall be configurable for manual or automatic start-up and shutdown. In automatic operation mode, the controls shall be capable of automatically starting and stopping the chiller according to a stored user programmable occupancy schedule. The controls shall include built-in provisions for accepting:
١) A minimum of two ٣٦٥-day occupancy schedules.
٢) Minimum of ٨ separate occupied/unoccupied periods per day
٣) Daylight savings start/end
٤) ١٨ user-defined holidays
٥) Means of configuring an occupancy timed override
٦) Chiller start-up and shutdown via remote contact closure

h. Service Function:
The controls shall provide a password protected service function which allows authorized individuals to view an alarm history file which shall contain the last ٢٥ alarm/alert messages with time and date stamp. These messages shall be displayed in text form, not codes.

i. Network Window Function:
Each chiller control panel shall be capable of viewing multiple point values and statuses from other like controls connected on a common network, including controller maintenance data. The operator shall be able to alter the remote controller's set points or time schedule and to force point values or statuses for those points that are operator forcible. The control panel shall also have access to the alarm history file of all like controllers connected on the network.

j. Pump Control:
Upon request to start the compressor, the control system shall start the chilled and condenser water pumps and shall verify that flows have been established.

k. Ramp Loading:
A user-configurable ramp loading rate, effective during the chilled water temperature pulldown period, shall prevent a rapid increase in compressor power consumption. The controls shall allow configuration of the ramp loading rate in either degrees per minute of chilled water temperature pulldown or percent motor amps per minute. During the ramp loading period, a message shall be displayed informing the operator that the chiller is operating in ramp loading mode.

l. Chilled Water Reset:
The control center shall allow reset of the chilled water temperature set point based on any one of the following criteria:
١) Chilled water reset based on an external ٤ to ٢٠ mA signal.
٢) Chilled water reset based on a remote temperature sensor (such as outdoor air).
٣) Chilled water reset based on water temperature rise across the evaporator.

m. Demand Limit:
The control center shall limit amp draw of the compressor to the rated load amps or to a lower value based on one of the following criteria:
١) Demand limit based on a user input ranging from ٤٠٪ to ١٠٠٪ of compressor rated load amps
٢) Demand limit based on external ٤ to ٢٠ mA signal.

n. Controlled Compressor Shutdown:
The controls shall be capable of being configured to soft stop the compressor. The display shall indicate "shutdown in progress."

٢. Safeties:

a. Unit shall automatically shut down when any of the following conditions occur (each of these protective limits shall require manual reset and cause an alarm message to be displayed on the control panel screen, informing the operator of the shutdown cause):
   ١) Motor overcurrent
   ٢) Over voltage*
   ٣) Under voltage*
   ٤) Single cycle dropout* (LF-٢ VFDs only)
   ٥) Low oil sump temperature
   ٦) Low evaporator refrigerant temperature
   ٧) High condenser pressure
   ٨) High motor temperature
   ٩) High compressor discharge temperature
   ١٠) Low oil pressure
   ١١) Prolonged stall
   ١٢) Loss of cooler water flow
   ١٣) Loss of condenser water flow
   ١٤) Variable frequency drive fault
   ١٥) High variable frequency drive temperature
   * Shall not require manual reset or cause an alarm if auto-restart after power failure is enabled.
b. The control system shall detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce chiller capacity when any of the following parameters are outside their normal operating range:
   ١) High condenser pressure
   ٢) High motor temperature
   ٣) Low evaporator refrigerant temperature
   ٤) High motor amps
   ٥) High VFD inverter temperature
c. During the capacity override period, a prealarm (alert) message shall be displayed informing the operator which condition is causing the capacity override. Once the condition is again within acceptable limits, the override condition shall be terminated and the chiller shall revert to normal chilled water control. If during either condition the protective limit is reached, the chiller shall shut down and a message shall be displayed informing the operator which condition caused the shutdown and alarm.
d. Internal built-in safeties shall protect the chiller from loss of water flow. Differential pressure switches shall not be allowed to be the only form of freeze protection.

٣. Diagnostics and Service:
   a. A self diagnostic controls test shall be an integral part of the control system to allow quick identification of malfunctioning components.
   b. Once the controls test has been initiated, all pressure and temperature sensors shall be checked to ensure they are within normal operating range. A pump test shall automatically energize the chilled water pump, condenser water pump, and oil pump. The control system shall confirm that water flow and oil pressure have been established and require operator confirmation before proceeding to the next test.
   c. In addition to the automated controls test, the controls shall provide a manual test which permits selection and testing of individual control components and inputs. A thermistor test and transducer test shall display on the ICVC screen the actual reading of each transducer and each thermistor installed on the chiller. All out-of-range sensors shall be identified. Pressure transducers shall be serviceable without the need for refrigerant charge removal or isolation.

٤. Multiple Chiller Control:
   The chiller controls shall be supplied as standard with a two-chiller lead/lag and a third chiller standby system. The control system shall automatically start and stop a lag or second chiller on a two-chiller system. If one of the two chillers on line goes into a fault mode, the third standby chiller shall be automatically started. The two-chiller lead/lag

system shall allow manual rotation of the lead chiller and a staggered restart of the chillers after a power failure. The lead/lag system shall include load balancing if configured to do so.

G. Electrical Requirements:
   ١. Electrical contractor shall supply and install main electrical power line, disconnect switches, circuit breakers, and electrical protection devices per local code requirements and as indicated necessary by the chiller manufacturer.
   ٢. Electrical contractor shall wire the chilled water pump and flow, condenser water pump and flow, and tower fan control circuit to the chiller control circuit.
   ٣. Electrical contractor shall supply and install electrical wiring and devices required to interface the chiller controls with the building control system if applicable.
   ٤. Electrical power shall be supplied to the unit at the voltage, phase, and frequency listed in the equipment schedule.

H. Piping Requirements — Instrumentation and Safeties:
   ١. Mechanical contractor shall supply and install pressure gages in readily accessible locations in piping adjacent to the chiller such that they can be easily read from a standing position on the floor. Scale range shall be such that design values shall be indicated at approximately midscale.
   ٢. Gages shall be installed in the entering and leaving water lines of the cooler and condenser.

I. Vibration Isolation:
   Chiller manufacturer shall furnish neoprene isolator pads for mounting equipment on a level concrete surface.

J. Start-Up:
   ١. The chiller manufacturer shall provide a factory-trained representative, employed by the chiller manufacturer, to perform the start-up procedures as outlined in the Start-Up, Operation and Maintenance manual provided by the chiller manufacturer.
   ٢. Manufacturer shall supply the following literature:
      a. Start-up, operation and maintenance instructions.
      b. Installation instructions.
      c. Field wiring diagrams.
      d. One complete set of certified drawings.

K. Special Features:
   ١. Soleplate Package:
      Unit manufacturer shall furnish a soleplate package consisting of soleplates, jacking screws, leveling pads, and neoprene pads.
   ٢. Spring Isolators:
      Spring isolators shall be field furnished and selected for the desired degree of isolation.
   ٣. Spare Sensors with Leads:
      Unit manufacturer shall furnish additional temperature sensors and leads.
   ٤. Sound Insulation Kit:
      Unit manufacturer shall furnish a sound insulation kit that covers the compressor housing, motor housing, compressor discharge pipe, suction line, evaporator, and economizer (if equipped).
   ٥. Stand-Alone Pumpout Unit:
      A free-standing pumpout unit shall be provided. The pumpout unit shall use a semi-hermetic reciprocating compressor with liquid-cooled condenser. Condenser liquid piping and ٣-phase motor power shall be installed at the jobsite by the installing contractor.
   ٦. Separate Storage Tank and Pumpout Unit:
      A free-standing refrigerant storage tank and pumpout unit shall be provided. The storage vessels shall be designed per ASME Section VIII Division ١ code with ١٥٠ psig (١٠٣٤ kPa) design pressure. Double relief valves per ANSI/ASHRAE ١٥, latest edition, shall be provided. The tank shall include a liquid level gage and pressure gage. The pumpout shall use a hermetic reciprocating compressor with water-cooled condenser. Condenser water piping and ٣-phase motor power shall be installed at the jobsite by the installing contractor.
   ٧. Building Control System Interface (LON):

The chiller control system shall have the ability to interface and communicate directly to the building control using a LON based system. The LonWorks Carrier Translator shall output data in standard LON profiles.

٨. Refrigerant Charge:
The chiller shall ship from the factory fully charged with R-١٣٤a refrigerant and oil.

٩. Thermal Insulation:
Unit manufacturer shall insulate the cooler shell, economizer, suction elbow, motor shell and motor cooling lines. Insulation shall be ١ in. (٢٥,٤ mm) thick with a thermal conductivity not exceeding

$$٠,٢٨ \ \frac{(\text{Btu} \cdot \text{in.})}{\text{hr. Ft}^{٢}\ \text{F}} \ \left(\ ٠,٠٤٠٤ \ \frac{\text{W}}{\text{m C}} \ \right)$$

and shall conform to UL standard ٩٤, classification ٩٤ HF-١.

١٠. Automatic Hot Gas Bypass:
Hot gas bypass valve and piping shall be factory-furnished to permit chiller operation for extended periods of time.

١١. Cooler and Condenser Tubes:
Contact your local Carrier Representative for other tube offerings.

١٢. Cooler and Condenser Passes:
Unit manufacturer shall provide the cooler and/ or condenser with ١, ٢ or ٣ pass configuration on the water side.

١٣. Nozzle-In-Head, ٣٠٠ psig (٢٠٦٨ kPa):
Unit manufacturer shall furnish nozzle-in-head style waterboxes on the cooler and/or condenser rated at ٣٠٠ psig (٢٠٦٨ kPa).

١٤. Marine Waterboxes, ١٥٠ psig (١٠٣٤ kPa):
Unit manufacturer shall furnish marine style waterboxes on cooler and/or condenser rated at ١٥٠ psig (١٠٣٤ kPa).

١٥. Marine Waterboxes, ٣٠٠ psig (٢٠٦٨ kPa):
Unit manufacturer shall furnish marine style waterboxes on cooler and/or condenser rated at ٣٠٠ psig (٢٠٦٨ kPa).

١٦. Flanged Water Nozzles:
Unit manufacturer shall furnish standard flanged piping connections on the cooler and/ or condenser.

١٧. Hinges:
Unit manufacturer shall furnish hinges on waterboxes to facilitate tube cleaning.

١٨. Optional Compressor Discharge Isolation Valve and Liquid Line Ball Valve:
These items shall be factory-installed to allow isolation of the refrigerant charge in the condenser for servicing the compressor.

١٩. Pumpout Unit:
A refrigerant pumpout system shall be installed on the chiller. Pumpout system shall include a hermetic compressor and drive, internal piping, internal wiring, and motor. Field-supplied main power wiring and water piping shall be required.

٢٠. BACnet Communication Option:
Shall provide factory-installed communication capability with a BACnet MS/TP network. Allows integration with i-Vu® Open control system or a BACnet building automation system.

٢١. Optional Seismic Isolation Package:
Package shall meet International Building Code and ASCE ٧ seismic qualification requirements in concurrence with ICC ES AC١٥٦ Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems. Manufacturer shall provide seismic certificate from OSHPD (California only).

٢٢. Unit-Mounted Variable Frequency Drive (VFD) with Built-In Harmonic LiquiFlo™ II Filter:
a. Design:
١) The VFD shall be refrigerant cooled, microprocessor based, pulse width modulated design. Water-cooled designs are not acceptable.
٢) Input and output power devices shall be Insulated Gate Bipolar Transistors (IGBTs).

٣) Rectifier shall convert incoming fixed voltage/frequency to fixed DC voltage.
٤) Transistorized inverter and control regulator shall convert fixed DC voltage to a sinusoidal PWM waveform.
٥) Low voltage control sections and main power sections shall be physically isolated.
٦) Integrated controls shall coordinate motor speed to optimize chiller performance over a wide variety of operating conditions.

b. Enclosure:
١) Pre-painted unit mounted, NEMA ١ cabinet shall include hinged, lockable doors and removable lifting lugs.
٢) The VFD shall have a short circuit interrupt and withstand rating of at least ٦٥،٠٠٠ amps.
٣) Provisions to padlock main disconnect handle in “Off” positions shall be provided. Mechanical interlock to prevent opening cabinet door with disconnect in the “On” position or moving disconnect to the “On” position while the door is open shall be provided.
٤) Provisions shall be made for top entry of incoming line power cables.

c. Heat Sink:
١) The heat sink shall be refrigerant cooled. Heat sink and mating flanges shall be suitable for ASME design working pressure of ١٨٥ psig (١٢٧٦ kPa).
٢) Refrigerant cooling shall be metered to maintain heat sink temperature within acceptable limits for ambient temperature.

d. VFD Rating:
١) Drive shall be suitable for operation at nameplate voltage ±١٠٪.
٢) Drive shall be suitable for continuous operation at ١٠٠٪ of nameplate amps and ١٥٠٪ of nameplate amps for ٥ seconds.
٣) Drive shall comply with applicable ANSI, NEMA, UL and NEC standards.
٤) Drive shall be suitable for operation in ambient temperatures between ٤٠ and ١٢٢ F (٤ and ٥٠ C), ٩٥٪ humidity (non-condensing) for altitudes up to ٦٠٠٠ ft (١٨٢٩ m) above sea level. Specific drive performance at jobsite ambient temperature and elevation shall be provided by the manufacturer in the bid.

e. User Interface:
A single display shall provide interface for programming and display of VFD and chiller parameters. Viewable parameters include:
١) Operating, configuration, and fault messages
٢) Frequency in hertz
٣) Load and line side voltage and current (at the VFD)
٤) kW
٥) IGBT temperature

f. VFD Performance:
١) The VFD Voltage Total Harmonic Distortion (THD) and Harmonic Current Total Demand Distortion (TDD) shall not exceed IEEE-٥١٩ requirements using the VFD circuit breaker input terminals as the point of common coupling (PCC).
٢) The VFD full load efficiency shall meet or exceed ٩٧٪ at ١٠٠٪ VFD rated ampacity.
٣) Active rectifier shall regulate unity displacement power factor to ٠,٩٩ or higher.
٤) Voltage boost capability to provide full motor voltage at reduced line voltage conditions.
٥) The VFD shall feature soft start, linear acceleration, and coast to stop capabilities.
٦) Base motor frequency shall permit motor to be utilized at nameplate voltage. Adjustable frequency range shall permit capacity control down to ١٥٪.
٧) The VFD shall have ١٥٠٪ instantaneous torque generation.

g. VFD Electrical Service (single point power):
١) The VFD shall have input circuit breaker with minimum ٦٥،٠٠٠ amp interrupt capacity.
٢) The VFD shall have standard branch oil pump circuit breaker to provide power for chiller oil pump.
٣) The VFD shall have standard ٣ KVA control power transformer with circuit breaker to provide power for oil heater, VFD controls and chiller controls.

٤) The branch oil pump circuit breaker and control power transformer shall be factory-wired.
٥) Input power shall be ٣٨٠/٤٦٠ vac, ±١٠٪, ٣ Phase, ٥٠/٦٠ Hz, ±٢٪ Hz.

h. Discrete Outputs:
١١٥-v discrete contact outputs shall be provided for:
١) Circuit breaker shunt trip
٢) Chilled water pump
٣) Condenser water pump
٤) Alarm status

i. Analog Output:
An analog (٤ to ٢٠ mA) output for head pressure reference shall be provided. This signal shall be suitable to control a ٢-way or ٣-way water regulating valve in the condenser piping.

j. Protection (the following shall be supplied):
١) Under-voltage
٢) Over voltage
٣) Phase loss
٤) Phase reversal
٥) Ground fault
٦) Phase unbalance protection
٧) Single cycle voltage loss protection (LF-٢ VFD only)
٨) Programmable auto re-start after loss of power
٩) Motor overload protection (NEMA Class ١٠)
١٠) Motor over temperature protection

k. VFD Testing:
The VFD shall be factory-mounted, factory-wired and factory-tested on the chiller prior to shipment.

٢٣. Unit-Mounted Variable Frequency Drive (VFD) without Built-In Harmonic Filter:

a. Design:
١) VFD shall be refrigerant cooled, microprocessor based, pulse width modulated design. Water-cooled designs are not acceptable.
٢) Output power devices shall be insulated gate bipolar transistors (IGBTs).
٣) Converter section with full-wave fixed diode bridge rectifier shall convert incoming fixed voltage/frequency to fixed DC voltage.
٤) DC link shall filter and smooth the converted DC voltage.
٥) Transistorized inverter and control regulator shall convert fixed DC voltage to a sinusoidal PWM waveform.
٦) Integrated controls shall coordinate the motor speed to optimize chiller performance over a wide variety of operating conditions.

b. Enclosure:
١) Pre-painted unit mounted, NEMA ١ cabinet shall include hinged, lockable doors and removable lifting lugs.
٢) VFD shall have a short circuit interrupt and withstand rating of at least ١٠٠،٠٠٠ amps.
٣) Provisions to padlock main disconnect handle in the “Off” positions shall be provided. Mechanical interlock to prevent opening cabinet door with disconnect in the “On” position or moving disconnect to the “ON” position while the door is open shall be provided.
٤) Provisions shall be made for top entry of incoming line power cables.

c. Heat Sink:
١) The heat sink shall be refrigerant cooled. Heat sink and mating flanges shall be suitable for ASME design working pressure of ١٨٥ psig (١٢٧٦ kPa).
٢) Refrigerant cooling shall be metered by integrated standard controls to maintain heat sink temperature within acceptable limits for ambient temperature.

d. VFD Rating:
١) Drive shall be suitable for nameplate voltage ±١٠٪.

٢) Drive shall be suitable for continuous operation at ١٠٠٪ of nameplate amps and ١٥٠٪ of nameplate amps for ٣ seconds.
٣) Drive shall comply with applicable UL, CE, and NEMA standards.
٤) Drive shall be suitable for operation in ambient temperatures between ٤٠ and ١٠٤ F (٤,٤ and ٤٠ C), ٩٥٪ humidity (non-condensing) for altitudes up to ٣٣٠٠ feet (١٠٠٦ m) above sea level. Specific drive performance at jobsite ambient temperature and elevation shall be provided by the manufacturer in the bid.

e. User Interface:
Displays shall provide interface for programming and display of VFD and chiller parameters. Viewable parameters include:
١) Operating, configuration and fault messages
٢) Frequency in hertz
٣) Load side voltage and current (at the VFD)
٤) kW (on the VFD interface)

f. VFD Performance:
١) VFD full load efficiency shall meet or exceed ٩٧٪ at ١٠٠٪ VFD Rated Ampacity.
٢) Base motor frequency shall be either ٥٠ or ٦٠ hertz.

g. VFD Electrical Service: (single point power):
١) VFD shall have input circuit breaker with minimum ٦٥،٠٠٠ amp interrupt capacity.
٢) VFD shall have standard ١٥ amp branch oil pump circuit breaker to provide power for chiller oil pump.
٣) VFD shall have standard ٣ kva control power transformer with circuit breaker provides power for oil heater, VFD controls and chiller controls.
٤) The branch oil pump circuit breaker and control power transformer shall be factory wired.
٥) Input power shall be ٣٨٠/٤٨٠ vac, ±١٠ percent, ٣ phase, ٥٠/٦٠ Hz, ±٣ Hz.

h. Discrete Outputs:
١١٥-v discrete contact outputs shall be provided for:
١) Chilled water pump
٢) Condenser water pump
٣) Alarm status.

i. Analog Output:
An analog (٤ to ٢٠ mA) output for head pressure reference shall be provided. This signal shall be suitable to control a ٢-way or ٣-way water regulating valve in the condenser piping.

j. Protection (the following shall be supplied):
١) Under-voltage
٢) Over voltage
٣) Phase loss
٤) Phase unbalance protection
٥) Programmable auto re-start after loss of power
٦) Motor overload protection (NEMA Class ١٠)
٧) Motor over temperature protection

k. VFD Testing:
The VFD shall be factory mounted, wire and tested on the chiller prior to shipment.

٢٤. Unit-Mounted Variable Frequency Drive (٥٧٥-v VFD) without Built-In Harmonic Filter:

a. Design:
١) VFD shall be refrigerant cooled, microprocessor based, pulse width modulated design. Water-cooled designs are not acceptable.
٢) Output power devices shall be insulated gate bipolar transistors (IGBTs).
٣) Converter section with full-wave fixed-diode bridge rectifier shall convert incoming fixed voltage/frequency to fixed DC voltage.
٤) DC link shall filter and smooth the converted DC voltage.
٥) Transistorized inverter and control regulator shall convert fixed DC voltage to a sinusoidal PWM waveform.

٦) Integrated controls shall coordinate the motor speed to optimize chiller performance over a wide variety of operating conditions.

b. Enclosure:
   ١) Pre-painted unit mounted, NEMA ١ cabinet shall include hinged, lockable doors and removable lifting lugs.
   ٢) VFD shall have an Amp Interrupt Capacity (AIC) of ٣٥،٠٠٠ amps and a withstand rating of ٢٥،٠٠٠ amps.
   ٣) Provisions to padlock main disconnect handle in the “Off” positions shall be provided. Mechanical interlock to prevent opening cabinet door with disconnect in the “On” position or moving disconnect to the “On” position while the door is open shall be provided.
   ٤) Provisions shall be made for top entry of incoming line power cables.

c. Heat Sink:
   ١) The heat sink shall be refrigerant-cooled. Heat sink and mating flanges shall be suitable for ASME design working pressure of ١٨٥ psig (١٢٧٦ kPa).
   ٢) Refrigerant cooling shall be metered by integrated standard controls to maintain heat sink temperature within acceptable limits for ambient temperature.

d. VFD Rating:
   ١) Drive shall be suitable for nameplate voltage ±١٠٪.
   ٢) Drive shall be suitable for continuous operation at ١٠٠٪ of nameplate amps and ١٥٠٪ of nameplate amps for ٣ seconds.
   ٣) Drive shall comply with applicable UL and NEMA standards.
   ٤) Drive shall be suitable for operation in ambient temperatures between ٤٠ and ١٠٤ F (٤,٤ and ٤٠ C), ٩٥٪ humidity (non-condensing) for altitudes up to ٣٣٠٠ feet (١٠٠٦ m) above sea level. Specific drive performance at jobsite ambient temperature and elevation shall be provided by the manufacturer in the bid.

e. User Interface:
   Displays shall provide interface for programming and display of VFD and chiller parameters. Viewable parameters include:
   ١) Operating, configuration and fault messages
   ٢) Frequency in hertz
   ٣) Load side voltage and current (at the VFD)
   ٤) kW (on the VFD interface)

f. VFD Performance:
   ١) VFD full load efficiency shall meet or exceed ٩٧٪ at ١٠٠٪ VFD Rated Ampacity.
   ٢) Base motor frequency shall be ٦٠ hertz.

g. VFD Electrical Service: (single point power):
   ١) VFD shall have input circuit breaker with minimum ٣٥،٠٠٠ amp interrupt capacity.
   ٢) VFD shall have standard ١٥ amp branch oil pump circuit breaker to provide power for chiller oil pump.
   ٣) VFD shall have standard ٣ kva control power transformer with circuit breaker provides power for oil heater, VFD controls and chiller controls.
   ٤) The branch oil pump circuit breaker and control power transformer shall be factory wired.
   ٥) Input power shall be ٥٧٥ vac, ±١٠ percent, ٣ phase, ٦٠ Hz, ±٣ Hz.

h. Discrete Outputs:
   ١١٥-v discrete contact outputs shall be provided for:
   ١) Chilled water pump
   ٢) Condenser water pump
   ٣) Alarm status.

i. Analog Output:
   An analog (٤ to ٢٠ mA) output for head pressure reference shall be provided. This signal shall be suitable to control a ٢-way or ٣-way water regulating valve in the condenser piping.

j. Protection (the following shall be supplied):
   ١) Under-voltage

٢) Over voltage
٣) Phase loss
٤) Phase unbalance protection
٥) Programmable auto re-start after loss of power
٦) Motor overload protection (NEMA Class ١٠)
٧) Motor over temperature protection

k. VFD Testing:
The VFD shall be factory mounted, wire and tested on the chiller prior to shipment.