Vertiv™ Liebert® DSE 400-500 kW Packaged Solution
GUIDE SPECIFICATIONS

1.0 GENERAL

1.1 Summary

These specifications describe requirements for a Thermal Management system. The system shall be designed to control temperature in rooms containing electronic equipment, with good insulation and vapor barrier. The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the room.

1.2 Design Requirements

The Thermal Management system shall be a Liebert outdoor packaged unit, factory-assembled unit <for building perimeter application with front return air and front supply> <for rooftop application with bottom return air and bottom supply>. Units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard, "CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment" and are marked with the CSA c-us logo.

The system is designed for sensible cooling only and shall have a net sensible cooling capacity of ____ BTUH (kW) based on an entering air temperature of ____ °F (°C) dry bulb and ____ °F (°C) wet bulb and a leaving temperature of ___ °F (°C) with an actual airflow of _____ ACFM. The unit is to be supplied with 480 volt/ 3 ph/ 60 Hz electrical service. Net capacities shall include losses due to fan motor heat. Dehumidification and Humidification shall be handled externally to the unit.

1.3 Submittals

Submittals shall be provided after the agreement of the proposal and shall include: Single-Line Diagrams; Dimensional, Rigging, Electrical, Energy Performance Data, Unit Performance Data, Piping and Electrical Connection Drawings.

Submittals shall be provided after the agreement of the proposal. Equipment production should not begin until the receipt of approved submittal drawings from the owner or engineer.

Submittals shall include:

1. Dimensional diagrams with overall dimensions, plan and elevation views, rigging points, weights and clearances.
2. Unit electrical values for MCA and MOP.
3. Electrical connection drawings.
4. Unit performance at design conditions including total and net cooling capacity, max KW and peak PUE. Additional airflow derived from leakage or displacement of economizing components over 1% of total supply airflow should be added to the supply and economizer fan calculations to meet the specified airflow. Exhaust Air Transfer Ratio, Outdoor Air Correction Factor and the correspondent pressure differential should be submitted per AHRI standard 1060 on air-to-air exchanger devices. Leaving supply air temperatures should include air temperature increase due fan heat.
5. Fan curves shall be provided showing the fan operating point.

6. Provide annual energy performance including annual PUE values using TMY3 hourly weather information grouped in bins for the specific location of the site. All electrical loads and additional fan power due leakage over 1% should be included in the calculation.

1.4 Serviceability/Access

The unit shall be designed so that all components are accessible for service and maintenance through the unit's back and top. No side or front access shall be required for routine service for the perimeter configuration; for the rooftop configuration access to the return air plenum shall be provided. Service or replacement of components through the datacenter space shall not be allowed. Filters shall be replaceable from the unit's floor level without the need of a ladder or reaching inside of the unit. To avoid contamination, the unit design shall allow washing condenser coils in place with no risk of water penetration to the data center area and without coming in contact with components that eventually will be in the data center air flow.

1.5 Acceptable Alternatives

Acceptable alternatives shall be permitted with engineer's prior approval only. Contractor to submit a detailed summary form listing all variations to include size deviations, electrical load differences, functional and component changes and savings to end user.

1.6 Quality Assurance

The specified system shall be factory-tested before shipment. Testing shall include but shall not be limited to: Quality Control Checks, Hi-Pot test, factory loaded controls sequences, individual component run test and full refrigerant charge. The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

1.7 Regulatory Requirements

1. Unit shall be CSA listed.
2. Unit shall be certified under UL1995.
3. Unit shall be tested in accordance of ASHRAE standard 37.

2.0 PRODUCT

2.1 Unit Base

Manufacturer shall provide a full perimeter base frame to support entire unit. Base frame shall be fully welded made of structural "C" channel with anticorrosive paint finish or equal. Paint shall be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 1,000 consecutive hours. Multiple removable lifting points shall be integrated into base frame. A galvanized floor grating shall be included covering walking space under condenser area.

2.2 Unit Casing

- Casing surrounding the data center air section including supply fans, filters and evaporator coils shall be double wall panels with 16 ga. galvanized painted metal for exterior walls and 20 ga. galvanized metal on interior walls (walls and floor). Wall insulation shall be 2" foam with an R value of 12.
- Roof above the evaporator compartment shall be sloped and sealed with an EPDM membrane construction on the exterior. Roof insulation shall be mineral wool with an R value of 11 with an interior liner.
- Liner of the panel shall have no contact with the exterior wall to provide a thermal break.
- Casing should be able to withstand 1.5 times the operating pressure or 6-inch w.g. whichever is less, with a deflection of no more than L/200.
- Casing Leakage shall be below 1% of full airflow capacity at 1.5 times maximum operating pressure as tested per AHRI Standard 1350.
- Door shall be the same construction and thickness of the panels. Door handles shall have a safety latch when opened with positive pressure.
- Exterior panel paint should be able to withstand a salt spray test in accordance with ASTM B117 for a minimum of 1,000 consecutive hours. Paint color shall be Liebert Pebble Gray (RAL 7032).
- Floor and base components in contact with the airstream shall have either sprayed foam or mineral wool insulation depending on location and unit configuration, both enclosed with a liner.

2.3 Airflow Configurations

Unit shall be constructed for the dedicated configuration from the factory.

1. **Front supply** – Front return. Unit designed for building perimeter installation shall have the supply air on the lower level of the front side of the unit. The return air inlet shall be at the upper level of the front side of the unit. The unit design should allow the unit installation as close to the building as the duct transition requires.
2. **Rooftop –** bottom supply/bottom return. Unit designed for rooftop installation shall have both air connections, supply and return at the bottom of the unit.
3. **Draw thru rooftop** – bottom supply/bottom return. Unit designed for rooftop installation shall have air connections at the bottom front supply and bottom rear return.

2.4 Unit Mounting

- Perimeter installation shall be mounted on slab or steel base with the full base supported.
- Rooftop units shall be installed on a curb or a structural base that provides full perimeter support. Curb and supply and return air ductwork to be provided by mechanical contractor.
- Unit installation on slab or roof design shall allow proper rainwater drainage away from the unit to prevent accumulation.

2.5 Supply Fans

- Provide four (4) direct-drive plenum fan array controlled by four VFDs for supply air. Fans shall incorporate a non-overloading type airfoil blade wheel made from aluminum. Performance ratings shall conform to AMCA Standard 205 (fan efficiency grade), 211 (air performance) and 311 (sound performance) and tested in an AMCA accredited laboratory. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air, and fan efficiency grade (FEG). Sound certification shall apply to both inlet and outlet sound power levels. Maximum vibration shall be within the limits of ANSI/AMCA 204 Fan Application Category BV-3.
- Motors shall be NEMA premium efficiency suitable for use with VFDs and shall have shaft grounding kits.
- Four (4) variable frequency drives shall be provided to control the fan array. Each VFD shall be properly sized, factory mounted, wired to the fan motor and commissioned.

2.6 Refrigeration System

2.6.1 Four Circuit Vertiv™ Liebert® DSE Packaged Solution

Each unit shall have four (4) independent refrigeration circuits and each circuit shall include liquid line filter drier, refrigerant sight glass with moisture indicator and electronic expansion valve. Compressors shall be located outside the air stream and shall be removable and serviceable from the back of the unit. Refrigeration system and all its components shall be factory tested and shipped with a full refrigerant load.

2.7 Compressors

2.7.1 Tandem Digital Scroll Compressors

The compressors shall be tandem, scroll-type with a variable capacity operation capability of one compressor of the pair. Compressor solenoid valve shall unload the compressor and allow for variable capacity operation. The compressor shall have vibration isolators, thermal overloads, automatic reset high-pressure switch with lockout after three failures, rotalock service valves, suction line strainer and a maximum operating speed of 3500 rpm. The compressor motor shall be suction gas cooled.

2.7.2 Crankcase Heaters

The compressors shall include crankcase heaters, powered from the indoor unit electric panel.

2.7.3 R-410A Refrigerant

The system shall be designed for use with R-410A refrigerant, which meets the U.S. Clean Air Act for phase-out of HCFC refrigerants. Unit shall ship with a full refrigerant charge from the factory.

2.8 Evaporating Coils

Coils shall be of copper tubes and aluminum plate fins with internally enhanced tubes. Tubes shall bond to the fins by mechanical expansion. Evaporating coils should have continuous fins to allow moisture to drip down to the bottom coil frame and to the drain pan. Microchannel evaporating coils shall not be used due to moisture carryover management concerns.

3.0 HEAT REJECTION

3.1 Condenser Section

The air-cooled condenser section shall provide positive refrigerant head pressure control to the evaporating coil by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency and significantly reduce the system refrigerant volume required. EC fans and fan operating techniques shall provide reduced maximum sound levels.

3.2 Heat Rejection Cabinet Section

The condenser cabinet shall be divided into fan and coil sections by full width baffles per corresponding Vertiv™ Liebert® DX circuits. Internal structural support members, including coil support frame, shall be painted or galvanized steel for strength and corrosion resistance. An electrical panel shall be contained inside a factory mounted, NEMA 3R weatherproof electrical enclosure.

3.2.1 Condenser Coils

Microchannel coils shall be constructed of aluminum microchannel tubes, fins and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins and aluminum headers shall be oven brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak-tested at a minimum of 300 psig (2068kPag). The unit is factory piped.

3.2.2 Condenser Fan

The fan motor/blade assembly shall have an external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close meshed steel wire, coated with a black corrosion resistant finish. Fan terminal blocks shall be located in an IP54 enclosure located on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment and mounted securely to the condenser structure.

3.2.3 EC Fan Motor

The EC Fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module, linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.

3.2.4 Refrigerant Receiver

Every refrigerant circuit shall contain a painted, uninsulated receiver with integral fusible plug and connected to the condenser liquid line.

3.2.5 Vertiv™ Liebert® EconoPhase Cycle

During cold outdoor temperatures, refrigerant pumps shall circulate refrigerant through the cooling system in lieu of operating the compressors. The compressors shall ramp down during Liebert® EconoPhase operation, and, if able to completely offset the load, the control system shall shut the compressors off. Refrigerant pumps shall be housed in an enclosure with each pump dedicated to its own refrigerant circuit. The Liebert® EconoPhase system shall include a variable-speed drive on each refrigerant pump to enable the pumps' speed to adjust in response to the load.

3.2.6 Condenser Electronic Controls

The condenser control system shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors and refrigerant pressure transducers. The condenser control board shall communicate directly with the unit's Vertiv™ Liebert® iCOM™ control via CANbus communication and low-voltage interlock wires. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling each EC fan on the same refrigerant circuit to the same speed. The condenser control system shall be rated to a temperature of –30°F to 125°F (–34.4°C to 51.7°C) and shall be factory-set for fan speed control with Vertiv™ Liebert® DSE receivers.

The mode of the condenser control board shall be controlled by Liebert® DSE, Liebert® iCOM™ control and shall be in either Vertiv™ Liebert® DX, Vertiv™ Liebert® EconoPhase or Idle Mode by each refrigerant circuit. Multiple circuit condensers shall operate fans to meet airflow needs and mode of each circuit independent of the other. Fan(s) on common refrigerant circuit shall operate in synchronous speed when that circuit is active.

3.2.7 Condenser Electrical Controls

Electrical controls and service connection terminals shall be provided and factory wired inside the control panel section.

4.0 ELECTRICAL

4.1 Power

As standard, the unit shall have a power input for lights and convenience outlets and a high voltage power input. Unit shall include a high voltage distribution block and main unit disconnect with lockout/tagout capabilities.

4.2 Locking Disconnect

A locking-type disconnect switch shall be factory-mounted and wired to the electrical panel. The switch shall be accessible from the back of the unit with the data center air section door closed and shall prevent access to the high-voltage electrical components until switched to the off position. The locking disconnect shall be lockable in support of lockout/tag-out safety programs.

4.3 Short Circuit Current Rating

The electrical panel shall provide at least 65,000A SCCR. Short-circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

4.4 Automatic Transfer Switch (Optional)

An optional dual power ATS shall be provided to automatically switch between the main and auxiliary power source when the main source has lost power. ATS status signal relays shall be available at the ATS and field wired to the building BMS.

5.0 CONTROLS

5.1 Vertiv™ Liebert® iCOM™ Microprocessor Control with 9-inch Color Touchscreen

The Liebert® iCOM™ shall be microprocessor-based with a 9-inch resistive color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the control panel is closed. The controls shall be menu driven. The system shall display user menus for active alarms, event log, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode.

- Password Protection – The Liebert® iCOM™ shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature shall allow the user to see applicable information based on the login used.
- Unit Backup and Restore – The user shall be able to create safe copies of important control parameters. The Liebert® iCOM™ shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
- Parameter Download – The Liebert® iCOM™ shall enable the user to download a report that lists parameter names, factory default settings and user-programmed settings in .csv format for remote reference.
- Parameter Search – The Liebert® iCOM™ shall have search fields for efficient navigation and parameter lookup.
- Parameter Directory – The Liebert® iCOM™ shall provide a directory that lists all parameters in the control. The list shall provide Line ID numbers, parameter labels, and current parameter values.
- Context Sensitive Help – The Liebert® iCOM™ will have an on-board help database. The database shall provide context sensitive help to assist with setup and navigation of the menus.
- Display Setup – The user shall be able to configure the display information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, back-light timer and the hide/show of certain readouts will be configurable through the display.
- Additional Readouts – The Liebert® iCOM™ shall enable the user to configure custom widgets on the main screen. Widget options shall include items such as fan speed, call for cooling, call for free cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling capacity.
- Status LEDs – The Liebert® iCOM™ shall provide the user with the unit's operating status using an integral LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.
- Event Log – The Liebert® iCOM™ shall automatically store the last 400 unit-only events (messages, warnings and alarms).
- Service Contact Information – The Liebert® iCOM™ shall have the capacity to store the local service or sales contact information.

- Upgradeable – Vertiv™ Liebert® iCOM™ firmware upgrades shall be performed through a USB connection.
- Timers/Sleep Mode – Menu shall allow various customer settings for turning unit on/off.
- Menu Layout – The menus will be broken out into two main menu screens: User screen and Service screen. The User screen contains the menus to access parameters required for basic unit control and setup. The Service screen is designed for service personnel and provides access to advanced control setup features and diagnostic information.
- Sensor Calibration – The menus shall allow unit sensors to be calibrated with external sensors.
- Maintenance/Wellness Settings – The menus shall allow reporting of potential component problems before they occur.
- Options Setup – The menus shall provide operation settings for the installed components.
- Auxiliary Boards – The menus shall allow setup of optional expansion boards.
- Various Sensors – The menus shall allow setup and display of optional custom sensors. The control shall include four customer-accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.
- Diagnostics/Service Mode – The Liebert® iCOM™ control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.
- Base-Comms for BMS Connectivity – The Liebert® iCOM™ controller shall provide one Ethernet Port and RS-485 Port dedicated for BMS Connectivity. Provides ground fault isolated RS-485 Modbus, BACnet IP & Modbus IP network connectivity to Building Management Systems for unit monitoring and management. Also, provides ground fault isolated 10/100 baseT Ethernet connectivity for unit monitoring and management. The supported management interfaces include SNMP for Network Management Systems, HTTP for web page viewing, SMTP for email, and SMS for mobile messaging. The Liebert® iCOM™ controller can support dual IP on a single network and one 485 protocol simultaneously.

5.2 Alarms

All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customer's Building Management System/Building Automation System. The Liebert® iCOM™ shall activate an audible and visual alarm in the event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity
- Low Humidity
- EC Fan Fault
- Change Filters
- Loss of Power

- Compressor Overload
- High Head Pressure
- Low Suction Pressure
- Custom Alarms
    - Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels.

Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a delay of 0 to 255 seconds.

5.3 Vertiv™ Liebert® iCOM™ Control Methods And Options

The Liebert® iCOM™ shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air flow and cooling capacity-based control sensors installed. Proportional and Tunable PID shall also be user-selectable options.

5.3.1 Controlling Sensor Options

The Liebert® iCOM™ shall be flexible in the sense that it shall allow controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:

1. Cooling Capacity
    - Supply
    - Remote
    - Return
2. Fan Speed
    - Supply
    - Remote
    - Return
    - Manual (for diagnostics or to receive a signal from the BMS through Liebert remote monitoring devices or analog input)
    - Static Pressure

5.3.2 Temperature Compensation

The Liebert® iCOM™ shall have the ability to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating to highest efficiency.

5.4 Multi-Unit Coordination

Liebert® iCOM™ teamwork shall save energy by preventing multiple units in an area from operating in opposing modes. Teamwork allows the control to optimize a group of connected equipped with Liebert® iCOM™ using the U2U (Unit-to-Unit) network. There shall be two modes of teamwork operation:

- Teamwork Mode 2 – (Independent): The Liebert® iCOM™ calculates the worse-case demand for cooling. Based on the greatest demand within the group, each unit operates independently, meaning that the unit may respond to the thermal load based on the units controlling sensors. All sensor readings are shared.

- Teamwork Mode 3 – (Optimized Aisle): May be applied in large and small rooms with varying heat loads. Optimized Aisle is the most efficient teamwork mode that allows the unit to match cooling capacity with heat load. In the Optimized Aisle mode, the fans operate in parallel. Fans can be controlled exclusively by remote temperature or using static pressure with a secondary remote temperature sensor(s) as an override to ensure that the inlet rack temperature is being met. Cooling (Compressors or Vertiv™ Liebert® EconoPhase) is controlled off unit supply air conditions. The Vertiv™ Liebert® iCOM™ calculates the average or worst-case sensor reading for cooling. Based on the demand within the group, units will be allowed to operate within that mode until room conditions are satisfied. This is the best form of control for a room with an unbalanced load.

5.5 Standby/Lead-Lag

The Liebert® iCOM™ shall allow planned rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units.

5.6 Standby Unit Cascading

The Liebert® iCOM™ cascade option shall allow the units to turn On and Off based on heat load when utilizing Teamwork Mode 3–Optimized Aisle mode with remote temperature sensors. In Teamwork Mode 3, Cascade mode will stage units on based on the temperature readings and their deviation from setpoint. Cascade mode coordinates the fan speed dynamically to save energy and to meet cooling demands. For instance, with a Liebert® iCOM™ group of six units and only 50% of the heat load, the Liebert® iCOM™ shall operate only four units at 80% fan speed and leave the other two units in standby. As the heat load increases, the Liebert® iCOM™ shall automatically respond to the new load and bring on another unit, increasing the units in operation to five. As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them back into standby.

5.7 Virtual Master

As part of the robust architecture of the Liebert® iCOM™ control, it shall allow for a virtual master that coordinates operation. The Virtual Master function shall provide smooth control operation if the group's communication is compromised. When the lead unit, which is in charge of component staging in teamwork, unit staging and standby rotation, becomes disconnected from the network, the Liebert® iCOM™ automatically assigns a virtual master. The virtual master shall assume the same responsibilities as the master until communication is restored.

5.8 Compressor Short Cycle Control

Compressor short cycle control shall be available to prevent compressor short-cycling and needless compressor wear.

5.9 Liebert Condenser Control and Liebert® EconoPhase Communication

Unit controller shall communicate with Liebert® EconoPhase and condenser controller via CANbus wires. This communication shall allow Liebert® iCOM™ to control condenser/ Liebert® EconoPhase modes and operation and to monitor their health and alarm status.

5.10 Wired Supply Sensor

Each Liebert® iCOM™ shall have one factory-supplied and connected supply air sensor for field installation that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

5.11 System Auto Restart

The auto restart feature shall automatically restart the system after a power failure. Time delay shall be programmable. A dedicated UPS feed shall be field provided for continuous control operation through a power outage.

5.12 Sequential Load Activation

On initial start-up or restart after power failure, each operational load shall be sequenced with a minimum of one second delay to minimize total inrush current.

5.13 Low-Pressure Monitoring

Units shall ship standard with low-pressure transducers for monitoring individual compressor suction pressure. If the pressure falls due to loss of charge or other mechanical cause, the corresponding circuit shall shut down to prevent equipment damage. The user shall be notified of the low-pressure condition through the local display and remote monitoring.

5.14 Winter Start Time Delay

An adjustable software timer shall be provided to assist with compressor starting during cold weather. When the compressor starts, the low-pressure input shall be ignored for the period set in the user-adjustable timer. Once the delay after the compressor start has elapsed, the low-pressure input should remain in the normal state. If the low pressure input does not remain in the normal state after the delay has elapsed, the circuit shall lock out on low pressure. The low-pressure alarm shall be announced on the local display and communicated to remote monitoring systems.

5.15 Advanced Freeze Protection

Units shall ship standard with advanced freeze protection enabled. The advanced freeze protection shall monitor the pressure of each circuit using a transducer. The control shall interact with the fan and compressor to prevent the unit coil from freezing if circuit suction pressure drops. Applying fan speed to direct expansion systems requires limitations to avoid freezing condensate on the coil when the unit operates below 100% fan speed. Vertiv™ Liebert® iCOM™ advanced freeze protection provides the ability to predict freeze conditions and correct this condition automatically by adjusting fan speed and compressor capacity. If a freeze condition is detected, the user shall be notified through the local display and remote monitoring systems.

5.16 Advanced High-Pressure Protection

When the compressor is initially activated, the system shall be monitored for a high pressure. When high pressure is detected, the control shall reduce the system discharge pressure by altering the compressor loading and the condenser fan speed, preventing circuit shut down. If the unit is unsuccessful in correcting the problem through this interaction, an alarm shall occur and the affected compressor shall be immediately locked off. The control shall automatically re-enable the compressor when pressure returns to a safe level.

5.17 Refrigerant Pressure Transducer Failure

The control shall monitor the high-side and low-side refrigerant pressure transducers. If the control senses that the transducer has failed, has been disconnected, shorted or the reading has gone out of range, the user shall be notified through the local display and remote monitoring. The corresponding circuit that the failure has occurred on shall be disabled to prevent unit damage.

5.18 Oil Return Protection

The control shall monitor compressor operation and staging to ensure that liquid and hot gas velocity are maintained for proper oil return to the compressor.

5.19 Digital Scroll High-Temperature Protection

The control shall monitor digital scroll temperature during unit operation. A compressor temperature limit shall be imposed to help prevent damage to the compressor. If the temperature reaches the maximum temperature limit, the compressor shall be locked out for 30 minutes and an alarm shall be annunciated on the local display and through monitoring. After the initial lockout, the control shall continue to monitor compressor temperature during the off-cycle and re enable the circuit once a safe operating temperature is reached and the 30 minutes has elapsed. The control shall store the number of high-temperature trips. The number of trips shall be accessible through the local display.

5.20 Digital Scroll Sensor Failure

The control shall monitor the status of the digital scroll sensor(s). If the control senses the thermistor becomes disconnected, shorted or the reading goes out of range, the user will be notified through an event on the local display and remote monitoring.

5.21 Compressor Sequencing

A user-selectable compressor sequencing parameter shall be provided and access through the local control. This sequencing parameter presents the user with three choices:

- Always use Compressor circuits 1 and 3 as lead compressor.
- Always use Compressor circuits 2 and 4 as lead compressor.
- Auto: The unit shall automatically stage compressors to keep each unit's run time within 8 hours of the other unit's run time.

Note: The Auto setting attempts to maintain equal run times between compressors. However, the control will not turn Off a compressor to equalize run time when it is needed to control the space.

- **First priority:** If the safety timings are acceptable for only one compressor, that compressor shall be the next to be started/stopped.
- **Second priority**: If all compressors are Off, the one with fewer working hours shall be the next to start.
- **Third priority**: If all compressors are in operation, the one that has been operating longer since the last start shall be the next to be stopped.

5.22 Compressor High- And Low-Temperature Limit Protection

The control shall monitor the return air to ensure that the compressor(s) are operated within the manufacturer's defined window of operation. If the return air temperature deviates from the manufacturer's window of operation, the Vertiv™ Liebert® iCOM™ shall automatically adjust to prevent damage to the cooling unit or reduction in its reliability.

5.23 Compressor Run Time Monitoring

The control shall log these compressor statistics:

- Number of compressors starts
- Run hours
- Average run time
- Starts per day
- Starts per day worst
- Number of high-pressure alarms

- Operating phase in which the high-pressure alarm occurred
- Number of low-pressure alarms
- Operating phase in which the low-pressure alarm occurred
- Number of compressor overloads
- Number of high-temperature alarms (scroll compressors)

The user shall have the ability to monitor compressor operating temperature and pressure from the local display to be used as a diagnostic tool.

5.24 Manual Compressor Disablement

The user shall have the ability to disable compressor operation using a set of either normally-open or normally-closed dry contacts tied directly to the control or through remote monitoring. An additional enable/disable feature shall be provided to allow the user to permanently disable an individual compressor circuit for maintenance using the local display.

5.25 Manual Compressor Operation

The user shall be able to operate each compressor manually from the local display. The user shall be able to energize refrigeration components including liquid-line solenoid valves, compressor contactors, electronic expansion valves and adjust capacity for troubleshooting or repair. The control shall monitor the compressor during manual operation and shall shut the compressor down if needed to prevent electrical or mechanical damage.

5.26 Optimization

Vertiv™ Liebert® DSE System Optimization - Allows for efficiency improvements for the Liebert® DSE system during Vertiv™ Liebert® EconoPhase mode. By optimizing liquid refrigerant temperature and pressure setpoints, the result is a reduction in power consumption of the condenser fan during mid and high ambient conditions. Liebert® DSE System Optimization provides an opportunity for additional energy savings by increasing the utilization of the Liebert® EconoPhase and decreasing the utilization of the condenser fans, but always maintaining appropriate heat capacity rejection during mid to high ambient outdoor conditions. Energy savings occurs when utilizing the Liebert® EconoPhase package; a pump consumes roughly 1/10th of the power consumed by the compressor.

5.27 Low Ambient

Low Ambient Standby Supply Fan Function – Controller routine to turn the supply fans on intermittently depending on outdoor ambient temperature even when the units are on standby mode to prevent condensation. This option can be disabled by the user.

6.0 MISCELLANEOUS OPTIONS

6.1 Quick Restart Function—Optional

When enabled, the quick-start feature will minimize time for reactivation of cooling components. After a loss of high volt power to the unit not exceeding 30 seconds, the quick start feature shall restart the unit in Vertiv™ Liebert® DX model with minimized delay times for reactivating the fan and compressor outputs. After high voltage power is restored, the Vertiv™ Liebert® DSE unit will continue operation and start in the last known cooling operating mode that was active prior to the loss of power. Unit restart time for full cooling shall be 60 seconds or less after power to the unit has been restored, with fans starting within 15 seconds. The unit shall be equipped with a field-provided UPS feed or a factory-installed capacitive buffer to provide the Vertiv™ Liebert® iCOM™ with a minimum of 3 minutes of ride-through power. The capacitive buffer shall provide power for continuous connectivity to the Building Management System(s) via Liebert® iCOM™ control.

6.2 2t Temperature Sensor – Optional

Optional vented case with two temperature probes shall be provided. Up to ten (10) 2T sensors (20 temperature probes) can be connected to a Liebert system. The sensors provide real-time, direct feedback to the cooling unit to optimize the amount of cooling and airflow provided; increasing energy efficiency and ensuring proper air temperatures at the measured point. The sensor data can also be reported to remote BMS and monitoring systems. The sensor network consists of a CANbus wire leaving the cooling unit (not included with the sensor) and connecting to a 2T sensor. Each remaining 2T sensor is connected to the previous sensor using optional length CAN cables; often referred to as a daisy-chain configuration.

6.3 Supply Air Aggregator Sensor – Optional

A control option that allows the use of the 1 NTC sensor that is already provided as a standard with the unit and the ability to ADD up to an additional five (5) 2T sensors to be used together to measure the supply temperature for a total of up to six (6) supply sensors. The ability to use multiple sensors to measure the supply temperature provides Liebert® iCOM™ the ability to control using the maximum or average of all the supply sensors. This is especially useful in application of ducted systems and non-raised floor application because of the ability to have additional sensors strategically placed to measure supply temperature but also provides benefits in raised floor applications.

6.4 Static Pressure Sensor – Optional

This controls option is a pressure transducer that shall be field installed and field wired to an analog input to the unit controller. The pressure ports shall be field installed with tubing connected as follows:

- High-pressure side: The pressure sensing tube/probe should be placed in the supply air stream that is directly influenced by the connected unit.
- Low-pressure side: The low-pressure side tube must route to an area to allow the pressure transducer to take an accurate atmospheric pressure reading of the conditioned space.

Teamwork 3 will allow the control to aggregate the static pressure readings from each unit in teamwork so they can be used together to control the unit using the minimum, maximum or average pressure of all sensors.

6.5 Vertiv™ Liebert® vNSA Network Switch-Optional

The Liebert® vNSA network switch is designed for networking multiple Vertiv™ Liebert® iCOM™ unit-level controllers together. There shall be two different styles of the vNSA14 panel available:

- Liebert® vNSA14 – enclosure with network switches only.
- Liebert® vNSA14-iCOM™-H – enclosure with network switches and 9" Liebert® iCOM™ color touchscreen display.

Each offering shall be housed inside a steel enclosure secured with a key lock and contain two network switches, providing a total of 14 Ethernet ports available for Liebert® iCOM™ controller unit-to-unit networking. The Liebert® vNSA requires field supplied, hard wiring, 16AWG, 100-240VAC universal (12V, 1.5A) single-phase input power supply for 120V or 230V operation with factory supplied power connector.

7.0 LIEBERT ROOF TOP CURB

7.1 Summary

These specifications describe requirements and options that must be considered for a Thermal Management system rooftop curb application. The curb is designed and furnished to be fully compatible with the requirements to install and run a Vertiv rooftop air handing unit.

7.2 Design Requirement

The Thermal Management curb shall be a manufactured in accordance National Roofing Contractors Associated guidelines for rooftop equipment.

7.3 Submittals

Submittals shall be provided with the proposal and shall include: Drawings.

7.4 Acceptable Alternatives

Acceptable alternatives shall be permitted via the Principle engineer's prior approval only. Contractor to submit a detailed summary form listing all variations to include size deviations, functional and component changes and to end user.

7.5 Quality Assurance

The system shall be designed and manufactured according to world-class quality standards. The manufacturer shall be ISO 9001 certified.

If equipment is supplied by a manufacturer other than Vertiv, coordinate with the General Contractor and affected subcontractors to ensure the specified performance is met. This coordination shall include (but is not limited to) the following:

- Structural supports for units.
- Size and location of concrete bases/housekeeping pads.
- Location of roof curbs, unit supports and roof penetrations.
- Ductwork sizes and connection locations.
- Piping size and connection/header locations.
- Interference with existing or planned ductwork, piping and wiring.
- Electrical power requirements and wire/conduit and over current protection sizes.
- Trap height requirement.

The Mechanical Contractor shall be responsible for costs incurred by the General Contractor, Subcontractors, and Consulting Engineers to accommodate units furnished by a manufacturer other than manufacturer named as basis of design

7.6 Knockdown Curb

7.6.1 General

The curb shall be designed to support the AHU and transfer the AHU load onto the roof's structure. The curb shall be field assembled either welded or mechanical assembled on site. A wooden nailer shall be provided by the manufacturer of the knockdown curb. The nailer shall be mechanically fastened to the perimeter of the curb and the space below the nailer shall insulated by others. The curb must be level (shim if required) and secured when placed on the roof. The curb joint/seams shall be sealed with suitable sealer/polyurethane caulk to prevent moisture leakage during unit operation. The field shall install cricket and flashing to curb to prevent moisture penetration.

7.6.2 Seismic

The curb and stand shall comply with the following seismic and wind load specifications:

Seismic parameters:

- IP = 1.5 (for structural integrity only, not functionality)
- SDS = 1.0g for z/h = 1 (rooftop)
- Wind parameters:
- Horizontal pressure = 47psf
- uplift pressure = 47psf

7.7 Standard Roof Equipment Curb

7.7.1 General

The curb shall be designed to support the AHU and transfer the AHU load onto the roof's structure. The curb is split into a main unit curb and condenser mechanical stand. The main unit curb shall connect the evaporator section to vertical supply and return deck units. The condenser mechanical section shall be supported by a mechanical equipment stand. All electrical connections, ductwork and control connections to be done by the contractor.

7.7.2 Main Unit Plenum Curb

1. Material

The curb material is galvanized steel and may vary from 18 to 14 gauge based on the unit load.

The factory provided cross brace must be installed under the evaporator section, the quantity, location and material gage to support the unit load will be furnished with the curb.

2. Construction Details

The roof curb shall be shipped loose for field installation prior to unit placement. The curb shall be installed in a level position to assure proper venting and drainage. The curb insulation and adhesive shall have an insulation value of a minimum of R10. All insulated materials shall be U.L. listed with a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50 per ASTM E84.

The adhesive shall comply with ASTM C916, Type I and insulation must be covered with an interior liner.

A thermal break shall be applied to prevent condensation, the only exception being hardware. If pre-galvanized sheet metal is used only hot-dip galvanizing steel sheet using the continuous (high-speed) galvanizing process will be acceptable (in accordance with ASTM A123). Electroplated metal is not acceptable in the airstream.

Flatness of sealing surfaces to be ±0.125 inches and Service platforms to meet OSHA safety requirements.

A flange is to be provided; that recesses from the curb up into the DP400/500B supply and return opening. The curb shall be furnished with a wood nailer, which provides a minimum of 3.5" of nailer surface, mounted at the top of the curb, to permit mechanical attachment of the flashing material.

Caution should be used when considering the use of wood that has been treated with an oil borne preservative for wood nailers. The oil that is used in many lumber treatments can act as a solvent on roofing materials and can cause bitumen drippage.

7.7.3 Condenser Mechanical Stand

1. Material

The mechanical stand consists of structural steel frames. The custom I-beams shall be formed to be an integral part of the AHU Structural Base Rail Support. The AHU must be supported in both length and width to ensure unit integrity.

2. Construction Details

The condenser stand shall have column supports which will support the structural steel wide flange I-beam frames. A column support may be considered a small or large penetration and should be flashed appropriately.

If the equipment includes the use of a separate frame supported by vertical supporting elements attached to the building structure, the vertical supporting elements are flashed as small penetrations. The clearance height measured from the metal panel to the bottom of the equipment support member should increase as the equipment width increases. Reference chart provided in the Construction Details section of The NRCA Roofing and Waterproofing Manual. See Detail S-MTL-17. The Curb shall have a minimum of R10 Insulation and Adhesive.

7.8 Adaptor Curb

7.8.1 General

Custom fabricated adaptor curbs are designed to retro-fit the current base curb when new air handling equipment is installed. Adaptor curbs eliminate costly reconstruction without disturbing the existing roof or ductwork. They also save engineering and construction time and reduce customer inconvenience.

All electrical connections, ductwork and control connections to be done by the contractor. The field shall install pipe chases, plumbing associated with drain pan drains and connections. The field shall install insulation on all staggered coil piping connections, both internal and external to the unit.

7.8.2 Prefabricated Insulated Roof Cub

Prefabricated roof curb to be manufactured of prime galvanized steel construction of 20, 18, 16, or 14 gauge as required, meeting ASTM A653/653M, with welded corners and with seams joined by continuous water and air tight welds. Roof curb shall be internally reinforced in the center and factory installed wood nailer. Internally insulated with 1-1/2" thick 3 lbs. density rigid insulation. Heights to must be above finished roof deck or as detailed. Top of all roof curbs shall be level, with pitch built into curb when deck slopes.

8.0 EXECUTION

8.1 Installation of Thermal Management Units

The customer or the customer's representative shall be responsible for the following:

8.1.1 General

Install Thermal Management units in accordance with the manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated and maintain the manufacturer's recommended clearances.

8.1.2 Rooftop Installation

Install Thermal Management units following NRCA guidelines for rooftop installation. Installer shall provide exterior catwalks depending of curb/dunnage height. Roof design shall allow proper rainwater drainage away from the unit to prevent accumulation

8.1.3 Electrical Wiring

Install and connect electrical devices furnished by the manufacturer but not specified to be factory mounted. Furnish copy of the manufacturer's electrical connection diagram submittal to electrical contractor.

8.2 Field Quality Control

Start cooling units in accordance with the manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. Verify proper field installation of supply air temperature sensor. These specifications describe requirements for a computer room environmental control system. The system shall be designed to maintain temperature conditions in the rooms containing electronic equipment.

8.3 Storage

For long term storage follow manufacturer’s instructions in the operating manual.

8.4 Warranty Start-Up and Control Programming

Install the unit in accordance with manufacturer's installation instructions.

Engage manufacturer's field service technician to provide warranty start-up supervision and assist in programming of unit(s) controls and ancillary panels supplied by them.