Alpha Consulting Engineers Pte Ltd

FEEDBACK REPORT FORM

Ref No: 158-.270314

To: LFY From: CCG

Job No./Project: Master Specification – ACMV (NSC & DSC) – Section 3 – Chillers, Cooling Towers & Pumps – Clause 3.4 Air-cooled screw chillers with inverter *(where applicable)*

Source of feedback:

Scope of Feedback: * [ ]Quality [ ]Environmental [ ]Administrative [ ]Contractual [ ]Technical [ ]Specification [✓]Others

Section A : Problem & Cause

There is no specification for VSD air-cooled screw chiller.

Section B : Mitigating Action Taken, if any

N.A.

Section C : Suggested Corrective Action

Incorporate the attached Mech Spec.

Section D : Approved Corrective Action

Document Affected * : [✓]Yes [ ]No Affected Document : Section 3 - ACMV Mech Spec.

Approved By : Date :

Section E : Action

Action By : CCG/KEA.

Targeted Completion : 12/3/2014

Actual Completion : 18/3/2014 Verified By :

* *Mark [X] where appropriate*

Distribution:

↳ To all staff via e-mail dated 27 March 2014

3.4 Air-cooled screw chillers with Inverter

Air-cooled chillers shall be supplied and installed generally as shown in the Specification Drawings. The chillers shall provide cooling capacity as shown in the Schedule of Technical Requirements and be capable of working at reduced load conditions down to 10% of its specified cooling capacity under specified operating condition.

The type of refrigerant shall be of HFC134a or other non-CFC refrigerant suitable for installation in building as approved by the local Authorities.

Each chiller shall be a self-contained unit complete with compressor, variable electrical frequency driver (VFD), air cooled condenser, evaporator, refrigerant circuit, control system, a complete set of safety devices and all necessary components for complete and efficient operation.

The chiller shall be factory assembled on a robust base frame made of galvanized steel, protected by epoxy paint. It shall be internally wired and charged with refrigerant and oil at the factory and delivered to the project site completely assembled. The on-site installation of the chiller must comply with the manufacturer's instructions for rigging and handling equipment.

Each chiller shall be tested in the factory at the specified working conditions and water temperatures at 25%, 50%, 75% and 100% load conditions prior to delivery to site.

A remote controller shall be provided for monitoring and control of the air cooled chiller. The remote controller shall be located in the nearest maintenance office or mechanical/electrical plant room as indicated in the Specifications Drawing.

The chillers shall be arranged to allow any of the machines to lead in the sequence of operation.

The chillers shall be arranged with isolating valves which will allow any of the chillers to be isolated without interrupting the operation of the other machines.

The compressor shall be connected with the chiller's metal base frame by rubber anti-vibration supports to prevent the transmission of vibrations to all metal unit structure, in order to control the unit sound.

The chiller shall be provided with an acoustical compressor enclosure. This enclosure shall be realized with a light, corrosion resisting aluminium structure and metal panels. The compressor sound-proof enclosure shall be internally fitted with flexible, multi-layer, high density materials.

a) <u>Compressor</u>

The compressor shall be of semi-hermetic, single-screw asymmetric type with one main helical rotor meshing with two diametrical opposed gaterotors. The gaterotors' contact elements shall be constructed of composite material designed for extended life. Electrical motor shall be 2-pole, semi-hermetic, squirrel-cage induction type and cooled by suction gas.

Oil injection to all moving compressor parts shall be provided using the refrigerant system differential pressure without the need for electrical oil pump lubricating system. The compressor shall be provided with a built in, high efficiency, mesh type oil separator and oil filter. Oil level sight glass and polyester synthetic oil charge shall be provided. The compressor shall also be equipped with an electric oil heater.

Compressor cooling must be done by refrigerant liquid injection. An external dedicated heat exchanger and additional piping to carry the oil from compressor to heat exchanger and vice versa is not allowed.

The compressor shall be directly electrical driven, without gear transmission between the screw and the electrical motor.

The compressor must be protected by a temperature sensor for high discharge temperature and an electrical motor thermistor for high winding temperature.

The compressor shall be fully serviceable on site. Compressor that must be removed and returned to the factory for service is not unacceptable.

b) Evaporator

The evaporator shall be of stainless steel plate heat exchanger with welded copper connections. Anti-freeze protection shall be provided during operation and shut down.

The units shall be equipped with a direct expansion shell & tube evaporator with copper tubes rolled into steel tube-sheets. The evaporator shall be single-pass on both the refrigerant and water sides for pure counter-flow heat exchange and low refrigerant pressure drops.

The external shell shall be linked with an electrical heater to prevent freezing down to -28°C ambient temperature, controlled by a thermostat and shall be insulated with flexible, closed cell polyurethane insulation material of minimum 20-mm thick.

The evaporator shall have multiple circuits, one for each compressor and shall be single refrigerant pass.

The evaporator, if classified by Occupational Safety and Health Division of Singapore Ministry of Manpower (MOM) as pressure vessel, shall be manufactured in accordance to approved design codes, such as British Standards (BSI) or American Society of Mechanical Engineers (ASME) Code.

c) Air Cooled Condenser

The air cooled condenser shall be of coils with slotted aluminium fins expanded into grooved copper tubes. The coil protection grille shall be made of steel wire, coated in polyethylene.

The condenser fans used in conjunction with the condenser coils shall be axial/propeller type with glass reinforced resin blades for high efficiencies and low noise operation. Each fan shall be provided with a fan shroud for vertical air discharge and complete with protection grille made of steel wire, coated in polyethylene.

The fan shall be driven by two-speed motor with NEMA insulation class F, IP 65 ingress protection rating and overload protection by thermal relay.

d) Refrigerant Circuit

There shall be minimum two refrigerant circuits for each chiller. Each circuit shall include electronic expansion device piloted by unit's microprocessor control, compressor discharge shut-off valve, liquid line shut-off valve, sight glass with moisture indicator, replaceable filter drier, charging valves, high pressure switch, high and low pressure

transducers, oil pressure transducer and insulated suction line. All components of the refrigerant circuit shall be welded for total and lasting leak-tightness.

e) Heat Recovery Exchanger

The unit shall be equipped with a plate to plate type heat exchanger for each refrigerant circuit, made of stainless steel brazed plates, for heat recovery function between the refrigerant circuit and external cold water system without affecting the chiller performance.

f) Power and Control Circuit Panel

All power and control circuit components shall be located in the power and control circuit panel attached/mounted to the chiller. The panel shall be manufactured to ensure protection against all weather conditions based on IP65 ingress protection rating and internally protected against possible accidental contact with live parts.

The power section shall include a main isolator switch, variable frequency driver (VFD), compressors and fans protection devices, compressors and fans starters and control circuit power supply.

All interconnecting wiring between the VFD and the chiller shall be factory-installed. Incoming electrical connection for compressor motor power shall be limited to main power leads to the single point power connection located inside the electrical power panel.

A separate control section shall be provided in the main panel to house all the extra low voltage control circuit components which shall include the microprocessor based controller.

g) Unit-mounted Variable Frequency Driver (VFD) and Electrical Requirement

The VFD shall be air cooled type. Water or refrigerant cooled type are not acceptable.

The VFD full load efficiency shall meet or exceed 97% at 100% VFD rated capacity.

Base motor frequency shall permit motor to be utilized at nameplate voltage. Adjustable frequency range, monitored by unit's microprocessor control, shall permit a stable unit capacity control down to 10% without hot-gas bypass.

Starting current for the compressor shall not exceed nominal compressor load amps and the unit power factor shall be not less than 0.95 on entire unit capacity range, from 100% down to 10%.

Power harmonics and radio interference generated by the VFD shall not exceed the levels as specified in BS EN 55014-1:2006+A2:2011 and any other limits allowed by the relevant authorities.

f) Controller

The chiller shall have a microprocessor-based controller for the control of the compressor capacity through inverter and the instantaneous RPM value of the motor. The controller shall be infinitely modulating each refrigerant circuit, from 100% down to 30% capacity and capable of maintaining stable operation to a minimum of 10% of full load without hot gas bypass.

The controller shall be able to control the unit based on the leaving evaporator water temperature using the PID (Proportional Integral Derivative) logic.

The controller shall manage the frequency level of the compressor electric motor to exactly match plant load request in order to keep constant the set point for delivered chilled or hot water temperature. In this operating condition, the controller shall modulate the electrical frequency level in a range lower and higher than the nominal electrical network value fixed at 50 Hz.

The controller shall also detect conditions that approach protective limits and take self-corrective action prior to an alarm occurring. The system shall automatically reduce the chiller capacity when any of the following parameters are outside their normal operating range:

- High condenser pressure
- Low evaporating refrigerant temperature

The controller shall be able to modify unit set-points and check control parameters with the following components:

- Built-in display to show the chiller operating status which include temperatures and pressures of water, refrigerant and air, programmable values, set-points.

- Intelligent software with predictive logic to select the most energy efficient combination of compressors, electronic expansion valves and condenser fans, to maintain stable operating conditions and maximize chiller energy efficiency and reliability.

- The controller shall be able to protect critical components based on external signals from its system (such as motor temperatures, refrigerant gas and oil pressures, correct phase sequence, pressure switches and evaporator). Input signals coming from the high pressure switch shall cuts all digital output from the controller in less than 50ms, as an additional security for the equipment.

- Fast program cycle (not more than 200ms) for a precise monitoring of the system.

- Floating point calculations support for increased accuracy in Pressure/Temperature conversions.

The controller shall also have the following features as minimum:

- Management of the compressor stepless capacity and fans modulation.

- Chiller enabled to work in partial failure condition.

- Full routine operation at condition of:

    - high ambient temperature value
    - high thermal load
    - high evaporator entering water temperature (start-up)

- Display of evaporator entering/leaving water temperature.

- Display of Outdoor Ambient Temperature.

- Display of condensing-evaporating temperature and pressure, suction and discharge superheat for each circuit.

- Leaving water evaporator temperature regulation (temperature tolerance = 0,1°C).
- Compressor and evaporator pumps hours counter.
- Display of Status Safety Devices.
- Number of starts and compressor working hours.
- Optimized management of compressor load.
- Fan management according to condensing pressure.
- Re-start in case of power failure (automatic / manual).
- Soft Load (optimized management of the compressor load during the start-up).
- Start at high evaporator water temperature.
- Return Reset (Set Point Reset based on return water temperature).
- OAT (Outside Ambient Temperature) reset.
- Set point reset.
- Application and system upgrade with commercial SD cards.
- Ethernet port for remote or local servicing using standard web browsers.
- Storage of at least two different sets of default parameters for easy restoration.

The chiller shall also be able to communicate to BMS (Building Management System) based on the most common open protocols such as:

- ModbusRTU
- LonWorks
- BacNet
- Ethernet TCP/IP.

g) Safety devices

Each unit shall be complete with safety devices such as overcurrent relay, overheat protection for discharge gas, high pressure switch, freeze-up protection thermostat, crankcase heater, reverse phase protector, fan motor thermal protector and other necessary safety devices to ensure a long life and trouble free operation.

h) Casing

The casing shall be made of galvanized sheet steel and painted with oven-baked polyester powder paint. The casing shall be completely weather proof.

Select only the type/types of cooling towers required

3.5 Cooling Towers

3.5.1 Induced Draught Cross Flow Cooling Towers