Karachaganak

Document owner: **Engineering and Technical Authority Manager**

Title: **HVAC Equipment**

Document No: **KPO-00-HVA-SPC-00004-E**

Supersedes Doc No: 23858-00L-3PS-MA14-00002

This is an uncontrolled copy unless it is being viewed on screen from the KPO Intranet.

Rev	Purpose	Date	Responsible	Accountable	Endorsed
A1	Issued for Use	28/01/2021	S. Kenzhaliyev Mechanical Engineer	N. Masilamani/ L.Spangolo Lead Mechanical and Piping Engineer	A.Zanoni Engineering Execution Manager

Revision History

Rev #	Purpose	Changes	Date	Responsible	Accountable	Endorsed
A1	Issued for Implementation		28/01/2021	S. Kenzhaliyev Mechanical Engineer	N. Masilamani/ L.Spangolo Lead Mechanical and Piping Engineer	A. Zanoni Engineering Execution Manager

Document Verification

RACIE Record

Responsible /	Name: Kenzhaliyev Syrym Job Title: Mechanical Engineer Signed: Date: 28/01/2021
Accountable /	Name: Masilamani Nandakumar/ Luigi Spangolo Job Title: Lead Mechanical and Piping Engineer Signed: Date: 28/01/2021
Endorsed /	Name: Antonello Zanoni Job Title: Engineering Execution Manager Signed: Date: 28/03/202
Document Owner (if different from Endorsed)	Name: Paolo Bernardi/ Harald Traa Job Title: Engineering and Technical Authority Manager Signed: Date: 29/3/2021
Consulted	PED Instrument, Electrical, Technical Safety, Process
Informed	Alzawar Hasan Kadhim Yousif/ Kuanysh Amirbekov – Electrical Superintendent

CONTENTS

1. INTRODUCTION - HEATING VENTILATION AND AIR CONDITIONING

This document outlines the minimum technical requirements for the design, supply of material and equipment, testing and commissioning of the complete HVAC installation.

The operation of the HVAC systems shall be fully integrated with all applicable fire/gas/smoke prevention/detection systems to provide a safe building environment under all foreseeable working conditions, and to meet in full the requirements of the Codes and Standards described throughout this document.

Details of the system design, as applicable to the above sites, are contained within the following project document:

- KPO-00-HVA-SPC-00003-E - HVAC Philosophy

Within this Specification the following definitions shall apply:

COMPANY = Karachaganak Petroleum Operating B.V.

SUPPLIER = SUPPLIER is official “Contactor” based on COMPANY Contract agreement including Sub-suppliers, and Manufacturer which will be involved in manufacturing process.

1.1. General

All equipment shall be supplied from sources capable of providing on site repair/ maintenance. Control systems and boiler burners tend to require relatively frequent servicing and shall be supplied from sources with an established servicing facility within the republic of Kazakhstan.

A refrigerant pumpout/receiver kit shall be provided for each type of refrigerant. The refrigerant pump out / receiver kit shall include all necessary connecting hoses, refrigerant measuring devices, refrigerant collection vessel and a full range of filters suitable for all possible system contaminants.

One complete set of tools shall be provided, suitable for the routine servicing of all HVAC equipment.

The location of all manufacturer trained service engineers shall be identified at bid stage.

Local/nearest stockists of all consumable items such as filter media, oil and refrigerants shall be identified at bid stage.

1.2. Equipment Design

All equipment shall be designed for 24 hours per day, year round operation. HVAC equipment design life shall be 20 years minimum under the specified conditions and shall have at least 2 years of uninterrupted operation.

For cooling applications refrigerant HFC-R134a or R-407C shall be used.

Equipment shall be suitably designed to withstand the prevailing environmental conditions. As a minimum the following provisions shall be made:

- Joints, access doors, panels, electrical equipment enclosures be forming part of externally located and equipment located within building deluge system area of operation, shall comply with the requirements of IP55.

- Joints, access doors, panels, electrical equipment enclosures forming part of internally located equipment shall comply with the requirement of IP31, with the exception of HVAC Control Panels/MCCs, which shall comply with IP54.

- Air intakes and discharges shall be located to prevent the ingress of piled sand or snow.

Where buildings/areas, containing HVAC equipment are designated hazardous (e.g. Zone 1 or Zone 2), all electrical equipment (e.g. control panels, motors, electric heaters etc.) and HVAC equipment (e.g. fans), shall be suitable for use in the area concerned. For area hazard classification, please refer to the COMPANY area classification drawings.

1.2.1. All electrical motors and associated wiring and ancillaries shall be in accordance with the following project specifications:

KPO-00-ELT-SPC-00016-ER- Low Voltage Induction Motors.

KPO-00-ELT-SPC-00018-E- Electrical requirements for packaged units

The following electrical supplies shall apply to all equipment:

Electric motors 0.00-0.50kW: 230v/50Hz/1ph

Electric motors 0.50-300.00kW: 400v/50Hz/3ph

1.2.2. All HVAC instruments, controls and associated wiring and ancillaries shall be in accordance with the following specifications:

KPO-00-ENG-SPC-00033-E	Power, control, instrument and telecommunication cable
KPO-00-INS-SPC-00015-E	Instrument Requirements for Package Units.
KPO-00-INS-SPC-00009-E	General Instrument Specification
23858-00L-3PS-JX04-00001	Instrument Piping and Tubing

1.2.3. All fresh air inlet stacks shall be designed in accordance with the following document:

KPO-00-CVS-SPC-00006-ER	Basic Civil Engineering Design Data

1.2.4. Instrument air is available at 6.0-8.0barg operating pressure and 10barg design pressure.

1.2.5. All equipment is to be capable of operation (as distinct from design basis temperatures) over the following temperature range: -45ºC to +50ºC unless stated otherwise.

For more information please refer to COMPANY Specification KPO-00-ENG-PHL-00009-E – Climatic, Environmental and Utility Data.

1.3. Applicable Codes and Standards

HVAC equipment shall be in accordance with:

- This specification, project datasheets and listed documents
- All mandatory local regulations
- Good engineering practice
- Applicable Codes and Standards referenced in Appendix I

The latest edition of all codes and standards apply.

In no case shall this specification be used to supersede, delete and/or lower applicable laws, applicable codes and/or local regulations requirements.

In the case of conflict between this specification, codes and standards, and any other specification noted herein, the most stringent shall apply. Any discrepancies shall be brought to the attention of the COMPANY.

1.4. System Pressures - Water System

1.4.1. Potable water

All equipment served with potable water from the site networked systems shall be rated for a mechanical design pressure of 7barg and a test pressure of 10barg.

1.4.2. Heating System

a) All equipment served with Di-Ethylene Glycol (DEG) is considered part of the site network DEG system and shall be rated as follows:

Mechanical Design Pressure:	10barg
Test Pressure:	15barg

b) All equipment used within self contained hot water heating systems, fired with fuel gas, shall be, at a minimum, rated for a mechanical design pressure of 6bar g and a test pressure of 9barg.

As these systems are autonomous, the SUPPLIER may select pressure exceeding the above minimum values. Should this occur, systems shall be rated at the higher pressures.

1.4.3. Chilled Water Systems

All equipment used within self-contained chilled water systems, shall be, at a minimum, rated for a mechanical design pressure of 6bar g and a test pressure of 9barg.

As these systems are autonomous, the SUPPLIER may select pressure exceeding the above minimum values. Should this occur, systems shall be rated at the higher pressures.

2. PIPEWORK SPECIFICATIONS

2.1. Distribution Pipework

a) Includes the following systems: heating, chilled water, domestic hot, cold, drinking water, and drain connections to adjacent floor wastes.

b) All pipework shall be constructed, installed and supported so that it is free from excessive stressing due to weight from its contents plus its own dead weight, dynamic forces due to liquid movement and expansion and contraction due to change in temperatures.

c) Sufficient union connections or flanged joints shall be installed to allow satisfactory removal of piping, valves, and fittings for inspection or repair.

d) All equipment to have flanged connections

e) Joints between piping and valves, oil traps, other steel or iron components or flanges shall be made in accordance with Vendor's recommendations. All bolts shall be galvanised. Steel flanges, except gasket surfaces, shall be painted.

f) Pipes connections at chilled water shall be installed with flexible connections to absorb any vibration set up by the compressor or other associated equipment without straining the pipe system.

g) All condensate pipework shall have tees at each change of direction to facilitate cleaning. Pipework shall be fitted with welded connections, isolating valve and screwed socket flanges for pressure gauge where required.

h) Condensate drain pipework shall be made from material resistant to corrosion. All installations to be of a suitable standard for the supply of drinking water. All necessary hygienic cleansing shall be carried out to achieve this requirement. All precautions, such as reduction in "dead leg" pipework lengths, shall be employed to minimise the risk of Legionella contamination.

i) Chilled Water and Hot Water Heating pipework and fittings shall be carbon steel.

j) The pressure drop in pipes shall never exceed 200Pa per metre. Moreover, in areas attended by personnel, the velocity shall remain less than 1m/s. It is mandatory for the filling system to include an additive dosing system and an antipollution check valve system.

k) The expansion/pressurisation unit, if required, shall be fitted with safety valves, manometer, high and low pressure warning indication capable of remote indication and duty/standby pumps. Pipework inside the buildings shall be designed in accordance with ASHRAE Handbooks or C.I.B.S.E. requirements.

l) Domestic water pipework, valves and fittings to comply with COMPANY specification KPO-00-PIP-SPC-00003-E, sanitary pipework classification A22 only. Isolation to fittings and ranges of sanitary fittings shall be achieved using butterfly or ball valves.

m) All piping, valves and fittings serving heating systems and chilled water systems are to comply with the COMPANY's Specification. KPO-00-PIP-SPC-00003-E, pipework classification A13 only. The above specification does not include strainers or commissioning valves, which are described in Section 10 of this document. Isolation of plant shall be achieved using butterfly or ball valves.

2.2. Pipe Thermal Insulation

The heating, chilled water, condensate from cooling coils, domestic hot water, chilled water and cold water pipework and all valves and accessories shall be insulated. Pipe insulation shall be in accordance with COMPANY specification KPO-00-PIP-SPC-00020-E – "Hot insulation of Piping, Tanks, Vessels, and Equipment". Preferred insulation shall be phenolic foam, having a thermal conductivity of 0.027W/mK at 50°C. Alternative insulating materials shall be considered, subject to approval. At pipe support locations, a high density, CFC free, phenolic foam of nominal density 80kg/m^3 shall be employed.

A continuous vapour barrier shall be employed on cold water and chilled water pipework. A weatherproofing agent shall be used on all external pipework insulation.

All pipework concealed in voids; exposed to view inside buildings but not liable to mechanical damage, shall have an external finish manufactured from a fire-retardant material.

Insulated pipework exposed to view and liable to mechanical damage, or located in the boiler house or in the air conditioning plant room, shall have an external finish of hammerclad aluminium jacketing.

3. DUCTWORK SPECIFICATIONS

3.1. HVAC Ductwork

General

Ductwork shall be designed in accordance with the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and SoR RoK 4.02-101-2012 – "Set of Rules RoK for Heating, Ventilation and Air conditioning". The maximum design air velocity shall be 7.5 m/sec in main ducts and 5 m/sec in branch ducts.

Fabrication and construction and pressure testing details shall be in accordance with the Heating and Ventilating Contractors Association specification for low velocity systems DW142/143 or other internationally accepted standard.

The installation contractor shall check the building dimensions and the dimensions and positions of plant on site before the fabrication of ductwork is started. All seams, joints and connections to plant shall be so made as to reduce air leakage to a minimum in accordance with the values detailed in DW142/143. Internal roughness and obstructions to airflow (other than dampers, vanes etc.,) and sharp edges or corners on the outside of ductwork, flanges, supports etc., will not be accepted. Any part of galvanised ductwork where the galvanising is damaged during manufacture or erection shall be painted with two coats of aluminium, zinc rich or other corrosion-resisting paint.

Volume control dampers shall be provided at all necessary locations, to properly balance the system.

All supply air ductwork, return air ductwork running in unconditioned spaces, and fresh air intake ductwork shall be insulated with a vapour sealed thermal insulation. Insulation shall extend down to the neck and cover the core of each supply diffuser. External ductwork, apart from fresh air ductwork, shall be insulated to a weatherproof standard.

Ductwork shall be of cold rolled continuously hot dipped galvanised, flat sheet steel.

Alternatively, where circular ductwork is required it may be provided as spiral wound duct. External ductwork shall be of 1.6mm minimum thickness for insulated ductwork. Uninsulated external ductwork shall be galvanised after manufacture, and of an adequate thickness to accept the galvanising process without distortion.

Connections to equipment shall be made with angle flanged joints. Ductwork, which may have to be moved, to enable plant to be accessed, shall incorporate angle-flanged joints. In plant room areas and for runs in excess of 5m in length, angle flanged joints shall be included at intervals to facilitate any subsequent alterations.

Bends and offsets shall have a minimum throat radius equal to the width of the duct.

All external ductwork or ductwork between the Air Handling Unit and the Sand Trap Air Inlet louvre shall be either 316L grade stainless steel or sheet steel, galvanised after manufacture.

All ductwork materials and supports installed internal to buildings shall be galvanised steel except the following, which shall be constructed from stainless steel 304L:

- Kitchen hood(s) exhaust duct.
- Dishwasher hood(s) exhaust duct.

- All ductwork materials and supports installed external to buildings shall be constructed from stainless steel 316L.
- Internal and external laboratory exhaust ventilation ducting and hoods shall be constructed from 316L stainless steel. To ensure that the material selected is suitable for any contaminants contained within the air stream, the SUPPLIER shall request confirmation from the COMPANY during the bid period that this material is still suitable.

All rectangular and round ducts shall be made in lengths appropriate to reinforcement and rigidity class required for pressure classification.

All ductwork shall be pressure tested for air tightness.

Earthing braid, bolted onto the duct shall connect sections of ductwork.

Rectangular ductwork shall be Pittsburgh lock formed, but the SUPPLIER may propose alternative jointing methods, subject to acceptance by the COMPANY. The ductwork shall be manufactured in accordance with the following schedule:

Major Dimension	Nominal Sheet Thickness	Max. spacing between Joints/Stiffeners	Min. sections for Intermediate Stiffeners
Mm	Mm	Mm	Mm
Up to 400	0.6	3000	None
400 - 600	0.8	2000	25 x 25 x 3
600 - 800	0.8	1600	40 x 40 x 4
800 - 1000	0.8	1250	40 x 40 x 4

Where duct sizes change, in all cases the larger dimensions shall determine the sheet metal thickness and stiffening.

Expansions shall be made upstream of a branch connection and contractions downstream of a branch connection. The slope of either an expansion or contraction shall not exceed 15 degrees on either side.

Ductwork supports shall be provided with spring vibration isolators, and insulating blocks where appropriate.

Flexible duct connections i.e., connections to prevent the transmission of vibration, shall be used at all connections to air handling units and in-line fans. Flexible connections shall not be used to as a means to correct mis-aligned equipment.

Where flexible ductwork is required between rigid ductwork and particular components or items of equipment, the internal diameter of the flexible duct shall be equal to the external diameter of the rigid ductwork and of the spigot served. The use of flexible duct between rigid sections of sheet metal ductwork to change direction or plan will not be permitted.

The flexible duct shall have a liner and a cover of tough tear-resistant fabric equal in durability and flexibility to glass fibre fabric and shall be impregnated and coated with plastics. It shall be reinforced with a bonded galvanised spring steel wire helix between the liner and the cover and an outer helix of glass fibre cord or equal shall be bonded to the cover to ensure regular convolutions.

The joints to rigid spigots shall be sealed with a brush coat of pipe jointing paste or mastic compound. Ducts up to 150mm diameter shall be secured with a worm drive type, hose clip. Ducts over 150mm diameter shall be secured with a band clip.

Where applicable i.e., to prevent condensation or heat loss or gain, flexible ductwork shall be insulated. Insulated flexible ductwork shall be factory pre-insulated glass fibre insulation blanket, sheathed in a vapour barrier of metalized polyester glass mesh material. Insulated flexible ductwork shall comply with requirements of NFPA 90A.

The frictional resistance to airflow per unit length of the flexible duct shall not exceed 50% more than the frictional resistance per unit length of galvanised steel ducts of equivalent diameter. The radius ratio R/D for bends shall not be less than 2, where R is the centre line radius and D is the diameter of the flexible duct.

The leakage from any section of flexible duct shall not exceed 1% of the design air flow rate through the section of duct in question at the static operating pressure.

Flexible ducts shall be suitable for an operating temperature range of -18 degrees C to 120 degrees C and shall have an external surface classified as very low flame spread. The material shall have a low smoke emission rate. All flexible ductwork shall be specifically approved by COMPANY before acceptance.

Kitchen Hoods and associated ductwork and grease filters

In addition to the requirements of the preceding sections of this document, joints between ductwork shall be flanged and shall ensure a smooth internal surface. Adequate access doors shall be provided at all changes of direction to allow cleansing of all internal duct surfaces.

Duct connections to hoods shall be vertical to avoid grease deposits.

All kitchen exhaust ducts shall be made with completely welded longitudinal joints to avoid grease leakage.

Grease filters shall be made of removable/cleanable cells made of stainless steel AISI 316.

Cell frame material shall be manufactured from the same material as the grease filters. Cells shall have a minimum thickness of 50mm, and shall be mounted within a frame linked to the hood.

The speed through cells (face velocity) shall be between 0.8 and 2.5m/s. Maximum pressure drop shall be 30-40Pa when filters are clean and 120Pa when dirty.

The arrangement of the hood shall be such that cells may be easily removed and replaced. Gutters or basins shall be provided beneath filters in order to collect melted grease. These collecting gutters shall be easily cleanable. An airtight seal shall be provided between cells and hood frame. The hood design is to be compatible with any fire protection system that may apply. (Fire Protection is not included with HVAC scope).

3.2. Ductwork Thermal Insulation

All supply or return air ductwork containing heated and/or cooled air shall be insulated. Phenolic foam slabs of density 40kg/m3 with factory applied flame retardant foil finish shall be employed. Alternative insulating materials shall be considered, subject to approval.

Ductwork insulation thickness and application of ductwork insulation shall be in accordance with COMPANY specification KPO-00-PIP-SPC-00020-E – “Hot insulation of Piping, Tanks, Vessels, and Equipment”.

A weatherproofing agent shall be applied in two coats to all external ductwork.

In the air conditioning plant room, ductwork insulation shall be finished with polymeric mastic coating or 22swg, hammerclad aluminium.

Care shall be taken to maintain the integrity of the vapour barrier at joints, exposed edges and where insulation pins or other protrusions penetrate the insulation.

3.3. Fresh Air Inlet Stacks

Fresh air inlet stacks shall be constructed from mild steel, galvanised after manufacture. All ancillary items, such as nuts, brackets, bolts and washers shall also be galvanised.

An inlet cap shall be provided to prevent the direct vertical ingress of snow, rain or sand. The thickness of the stack material and method of construction shall be sufficient to accept all structural, seismic and wind loading. Fresh air inlet stacks shall be free-standing (no guy ropes) with all structural loading calculated in accordance with the relevant codes and standards.

4. COOLING SYSTEMS

4.1. Air Cooled Condensing Units

The condensing units shall incorporate the following features:

- High-pressure compressor safety switches
- Overcurrent protection relays
- Crankcase heaters
- Electrical isolators mounted on uprights, for incoming power supplies.
- Flare couplings and service valves
- The condensing coils shall be air-cooled. The underside of all air intakes shall be a minimum of one metre above ground.

Direct expansion air-cooled condensing units shall be provided with:

- Multiple reciprocating compressors
- Multiple refrigerant circuits of equal duty

Each unit shall be complete with all-necessary controls and instrumentation required, ensuring the fully automatic control of the unit.

The unit shall be designed to prevent the occurrence of excessive vibrations resulting from the operation at full or partial capacity.

The condenser design basis shall include:

- Condensing temperature
- Cooling medium conditions

Air-cooled condensers shall have tinned, copper tubes and fins other corrosion protection systems shall be considered, subject to approval. Condenser coils shall have a minimum fin spacing of 2.5mm (10 fins/inch).

The equipment shall be suitable for mounting externally and shall be suitably weatherproofed and protected against the prevailing environment. The equipment shall be capable of operation, (as distinct from design basis) in the cooling mode at ambient dry bulb temperatures ranging from **-15**°C to +50°C and suitable for installation at -45°C.

4.2. Air Cooled Condensers (serving DX Systems)

Air cooled condensers, in conjunction with remote compressors, may be used, where there is a requirement to incorporate the compressor section of the refrigeration unit, within the building. This arrangement allows maintenance of the compressor to be carried out within the building and also protects the compressor from the weather.

This arrangement can increase the risk of noise transmission from the compressors into the building. The technical specifications for items shall be as the appropriate sections of this document applying to Air Cooled Condensing Units.

4.3. Air Cooled Water Chillers (with integral condensers)

All chillers shall be skid mounted, packaged units, factory assembled and tested, suitable for outdoor mounting. Chiller compressors shall be of the centrifugal, screw or reciprocating type, using refrigerant HFC-R134a or R-407C or other ozone friendly refrigerant permitted to use in RoK.

Each chiller shall include centrifugal, screw or reciprocating compressor, evaporator, air- cooled condenser, microprocessor-based control panel, starter, thermal expansion valves.

Air-cooled condenser shall be vertical discharge, low speed, direct or belt driven.

Cooling fans shall be axial, mixed flow or centrifugal type, dynamically balanced.

Spacing between fins shall be never less than 2.5mm (10 fins/inch).

Air-cooled condensers shall have tinned, copper tubes and fins, other corrosion protection systems shall be considered.

The equipment shall be suitable for mounting externally and shall be suitably weatherproofed and protected against the prevailing environment. The equipment shall be capable of operation, (as distinct from design basis) in the cooling mode at ambient dry bulb temperatures ranging from **-10°C to +50°C** and suitable for installation at -45°C.

Microcomputer control shall provide all control functions including start-up and shut down, leaving chilled water temperature control, compressor, anti-recycle logic and load limiting required to ensure the fully automatic control unit.

Adaptive microprocessor control shall prevent unit shutdown due to abnormal operating conditions associated with low refrigerant temperature, high condensing temperature and motor overload.

The microprocessor control unit shall be integral with the equipment that it controls. It shall be protected against the ingress of dust and moisture at the same standard as the equipment that it controls.

Unit protective functions shall include:

- Loss of chilled water flow
- Evaporator freeze protection
- Low or high refrigerant pressure
- Reverse rotation
- Compression starting and running over current
- Phase loss
- Phase imbalance
- Phase reversal and loss of oil flow

High and low pressure gauges shall be provided on the chilled water units.

The units shall be designed to prevent vibrations resulting from operation at full or partial capacity.

All surfaces which operate below the outside air design dew point shall be insulated to prevent condensation.

Design of packages shall facilitate easy access for inspection and maintenance of the equipment. All instrumentation and control equipment on chillers shall be as per manufacturer standard type.

A programmable module shall also be provided to control the operation of the chillers.

The main function of the programme module shall be:

- Chiller sequencing
- Control of the auxiliaries
- Optimisation of the start/stop time of the installation
- Staged loading and unloading
- Communication capabilities

4.4. Water Chillers with Remote Air Cooled Condensers

Air-cooled condensers may, in conjunction with remote liquid chillers, be used where there is a requirement to locate the water chiller within the building. This arrangement allows maintenance of the water chiller to be carried out within the building and also protects the compressor from weather.

This arrangement can increase the risk of noise transmission from the chillers in to the building. The technical specifications for these items shall be as the appropriate sections of this document applying to Air Cooled Water Chillers.

5. AIR SYSTEMS

5.1. Air Handling Units and Multi-Zone Units

All surface finishes on the inside of the unit, heat exchange coils and fans should be resistant to the prevailing atmospheric conditions.

Where dampers are employed they shall be of the opposed blade, aerofoil type with geared linkages and self-lubricating bearings. Blades shall have seals at interlocking, leading and trailing edges and be of factory galvanised steel construction. A crankarm shall provide connection to an activator.

Panels shall be insulated throughout with 32kg/m^3 fire resistant fibreglass. Access doors shall be hinged and provided with quick release catches having external and internal handles. Access to all components requiring maintenance shall be on one side of the unit.

Measures shall also be taken to prevent condensation on all exposed cold surfaces including bolts, screws, brackets and fixings.

Duct connections on the suction and discharge sections shall be provided with angle iron flanges. Flanges shall be a minimum of 50mm from the unit casing.

The AHU's shall have smooth internal surfaces to allow easy cleaning and reduce the accumulation of dirt and bacteria.

Individual components shall be mounted in a purpose made double skin factory galvanised steel panel with 25mm minimum of thermal insulation and an external polyester paint finish of minimum thickness 50microns.

The units shall include the following components as applicable:

a) V-belt driven supply/exhaust fan with backward curved, aerofoil, impellers on the larger fans. On smaller units, forward curved, multiblade impellers shall be allowed. The fan and motor package shall be mounted on a common base framed and insulated from the unit casing by means of anti-vibration mounts and a flexible discharge sleeve.

b) Three way mixing box with opposed blade dampers having geared linkages and self-lubricating bearings. Damper blades shall be of the aerofoil type with seals at interlocking, trailing and leading edges. The blades and casing shall be of factory galvanised sheet steel construction. Crankarms shall provide connection to pneumatic or electronic actuators supplied by others.

c) Panel filter of 85% efficiency under the ASHRAE gravimetric test and of fire rating M1. Air velocity through the filter shall not exceed 2.6m/sec.

A manometer shall be included in order to monitor the pressure drop across the filter.

d) Bag filter of 95% efficiency under the ASHRAE opacimetric test and of fire rating M1. Air velocity through the filter shall not exceed 2.6m/sec. A manometer shall be included in order to monitor the pressure drop across the filter.

e) Hot water air heating coil. Air velocity through the heating coil shall not exceed 3.75m/sec. The heating coil shall be mounted on tracks for lateral withdrawal. The preferred coil construction shall be grade 304 stainless steel tubes and aluminium fins alternative constructions shall be considered, subject to approval. Coil headers shall have screwed connections and all headers shall be located on the same side of the unit and provided with air vent and drain. Connections shall be arranged at in order to aid venting and drainage. Counter flow connections shall be the preferred arrangement in order to obtain the maximum mean temperature difference. Where installed as filter protection heaters, coils shall have smooth, easy clean tubes with adequate cleaning facility via access sections.

f) Duct Mounted Electric Heating Coils

These shall consist of a number of heating elements mounted in a sheet steel casing. The elements shall be covered with a shielding material to prevent direct contact with the airflow and so installed that they can be removed for cleaning or renewal without dismantling the casing. Where installed as filter protection heaters, coils shall be suitably weatherproof and cleanable via access sections.

g) Chilled water cooling coil, airside face velocity shall not exceed 2.6m/sec. The cooling coil shall be mounted on tracks for lateral withdrawal and located in a drain pan with a condensate connection. The coils shall have a maximum of 8 rows. Fresh air coils shall be of tinned copper tube and fin construction. Alternative corrosion protection systems shall be considered, subject to approval. Coils handling recirculation air shall have copper tubes with aluminium fins. Coil headers shall have screwed connections and provided with air vent and drain. All headers, vents and drains shall be located on the side of the unit containing the access panels. The flow connection shall be arranged at the lowest point and the return connection at the highest point in order to aid venting. Direction of water flow shall be counter to the direction of airflow.

A drain pan shall be provided under cooling coil, supply and return pipes, control valves and any component where condensation may occur. The pan shall be of sufficient size to catch all condensate drips from any part of the unit. This shall include the start up situation when room internal air has high moisture content. The drain pan shall be of stainless steel 316L and shall be watertight. The pan shall be insulated by closed cells foam to prevent condensation on the pan itself.

Coils with a finned height higher than one meter shall be fitted with an intermediate condensate pan discharging into the main pan.

The drainpipe equipped with a syphon shall be connected on site to a galvanised or PVC pan. The Vendor shall determine the design of the condensate discharge syphon required for a correct operation of the air-handling unit.

Air release valves and water drain cocks shall be fitted accessible positions to each coil.

h) Direct Expansion (DX) Cooling Coils

Coils shall be sized on a maximum air velocity through the face area of 3 meters per second, or on a velocity that does not permit moisture carryover, whichever is the lesser value.

Direct expansion (DX) cooling coil shall be horizontally split, with multi-row tubes and fins, Fresh air coils shall be of tinned copper tube and fin construction. Alternative corrosion protection systems shall be considered, subject to approval. Coils handling recirculation air shall have copper tubes with aluminium fins. Fins shall be mechanically bonded to tubes. DX coil shall be provided with thermostatic expansion valves, refrigerant service valves, filter drier, sight glass, low ambient control, and anti-shortcycle controls.

The coil frame shall be made of galvanised steel.

The coils with a finned height higher than one meter shall be fitted with an intermediate condensate pan discharging into the main pan.

Casing shall be designed such that centre supporting of coil is not required.

Coil and drain pan shall be installed on slide tracks for ease of removal.

Piping connections shall be located on the same side of the coil.

The drainpipe equipped with a syphon shall be connected on site to a galvanised or PVC pan. The Vendor shall determine the design of the condensate discharge syphon required for a correct operation of the air-handling unit.

i) 500mm wide (minimum) access sections shall be provided where cleaning or maintenance access is required. Removable, airtight access panels or airtight doors are to be included.

j) Adequately sized plenum mixing boxes, complete with all necessary control or balancing/isolating dampers.

5.2. Exhaust Fans

a) Roof mounted extract units shall be of the mixed flow non-overloading type mounted in a weatherproof enclosure. All moving parts of the unit shall be accessible either by removal of the unit cowl or from beneath the units. The SUPPLIER shall decide the type of access required. The extract units shall be of the cowled, horizontal, discharge type. Electrical component protection shall be to a minimum of IP55. All fans shall be selected to ensure that snow piling does not affect normal operation.

The accessories shall consist of a combination of the following:

- Backdraft damper
- Protection Guards
- Acoustic upstands if required to maintain space NC levels.

b) In line centrifugal fans up to a flowrate of 1250m3/hr for typical applications such as bathroom, toilet and laundry exhaust shall incorporate a backdraft shutter and ductwork shall terminate at a wall grille and not through the roof wherever possible.

c) Units shall incorporate adjustable run-on timers with the option of continuous running. Externally mounted units shall be weatherproof.

d) In-line fans with a flow rate in excess of 1250m3/hr shall be of the direct drive, long cased axial type, complete with mounting feet, inlet and discharge attenuators, as appropriate, access door and flexible duct connections. Fans serving occupied areas shall not exceed 1440 revolutions per minutes (r.p.m.).

e) Laboratory and battery room exhaust air fans shall be constructed from materials suitable for the fumes and contaminants liable to be present in the exhaust air stream.

Motors shall be located external to the air stream or fans shall be of the bifurcated construction. The design of fans and motors shall preclude the ignition of any explosive gases liable to be present within the air stream.

Fans shall be fully accessible for maintenance purposes.

5.3. Gas Boiler Ventilation Systems

a) Ventilation systems shall be capable of providing air for cooling, boiler combustion and gas safety requirements.

b) Ventilation systems shall comply with the requirements of the boiler manufacturer and allow complete combustion of fuel and safe operation of the equipment at its rated output.

c) Ventilation systems shall remove adequate amount of heat from the room while not adversely affecting the boiler combustion air requirements.

d) Air inlets and exhaust must not be capable of being obstructed by movable objects or manually isolated.

e) Incoming air must be heated before entering boiler room.

f) All ventilation systems to be mechanical and have 100% redundancy on all fans. Interlocks to be provided to prevent boiler operations should any fan, or its standby unit, not operate.

6. AIR HEATING AND CONDITIONING

6.1. Duct Mounted Humidifiers

Humidifier section shall be located downstream from the supply fan section or within each air-handling unit. Humidifier shall be electrode boiler or evaporative, water pack type.

Access doors shall be located on either side of humidifier. Doors shall be in an accessible position and preferably located on the larger duct dimension. Door size shall the maximum possible, commensurate with duct size.

Evaporative Humidifier:

Each humidifier shall comprise stainless steel casing holding a fire resistant, glass-fibre pack. The pack shall be complete with the following:

- Water distribution header assembly.
- Float control valve.
- Drain valve.
- Bleed-off drain.
- Bleed-off control valve.
- Pump.
- Overflow outlet.
- Pressure reduction.

Steam Humidifier:

Humidifier shall be dry steam, electrode boiler type, providing full separation of condensate from steam before injection into air stream.

Humidifier shall introduce steam directly into the airstream through a jacketed manifold that prevents condensate from being introduced into the airstream.

Humidifier shall be supplied with a cast iron in-line strainer and a cast iron float and thermostatic or inverted bucket steam trap. The strainer shall have a no-crush screen.

Humidifier shall have a cast iron or stainless steel separator to receive steam at operating pressure and remove water droplets and particles when operating at maximum capacity. The separator shall be located ahead of the control valve. A drip leg shall be supplied with the separator and shall be sized according to steam capacity. The drip leg shall be at the bottom of the separator, located ahead of the steam trap.

The control valve shall be stainless steel, steam jacketed, with a parabolic plug. The control valve shall be capable of modulating flow over entire stroke. The control valve operator shall stroke the valve over entire range and shall be capable of tight shutoff at the maximum pressure.

Humidifier shall be supplied with internal drying and silencing chambers, jacketed by steam, at atmospheric pressure. The silencing medium shall be stainless steel.

Distribution manifolds shall be stainless steel, steam jacketed. The manifold shall be provided with stainless steel silencing screen over entire length. The manifold jacket shall allow condensate to return to the trap.

All necessary items shall be included to ensure full operation of the humidifier, including, but not limited to:

- Distribution Pipe
- Disposable or cleanable generating cylinder
- Water filter (cleanable or disposable type)
- Drain valve
- All necessary control including, step controllers or thyristor controller, to achieve the design humidity requirements
- Miniaturised Circuit Breaker (M.C.B) to ensure protection against any abnormalities that may occur within the cylinder
- High water level cut-out
- Time counter, indicating number of hours of steam production
- On/off switch
- Low water level switch
- Safety overflow
- Control circuit fuse
- High limit humidistat
- Pilot lamps: on/off and fault.

Water quality dictates that chemical treatment shall be provided to the humidifier supply. The supply has TDS at 806mg/lt. and a conductivity of 1150 microsiemens.

6.2. "Through Wall" Room Air Conditioning Units

The "through wall" room air conditioning units shall include the following major components in a purpose made internally insulated steel casing with baked enamel finish:

a) Centrifugal fan

b) Direct expansion cooling coil, refrigerant compressor and air-cooled condenser.

c) Permanent washable air filter

d) Supply air grille with directional louvres, capable of adjustment in both horizontal and vertical plans

e) A moisture disposal system, piped to an discharge point not liable to be affected by sand piling

The units shall come complete with thermostat and, at a minimum, a 3-speed fan control. The unit shall be capable of automatic changeover between the heating and cooling modes.

Particular care shall be exercised in the selection of these units to prevent excessive noise. Units with 3 speed evaporator fan controllers shall be selected at fan speed No. 2. Noise levels shall be in accordance with MCN 2.04-03-2005 – "Noise protection" and Order of the Minister of National Economy of the Republic of Kazakhstan No 169, dated 28 Feb 2015.

Care is required to ensure unit size and weight is compatible with the building construction.

6.3. Hot Water Unit Heaters

Each unit heater shall comprise zinc protected steel casing, direct driven fan with IP55 motor, hot water heating coil, EU3 filter, frost protection thermostat, pneumatically operated shut off damper and a discharge air grille capable of vertical and horizontal air flow adjustment. Coil construction shall be in accordance with section 6.4 of this document, dealing with 'Duct Mounted Heating Coils.'

6.4. Duct Mounted Hot Water Heating Coils

Coils shall have type 304 stainless steel tubes with aluminium fins and shall have headers with same end screwed connections. The flow connection shall be arranged at the lowest point and the return connection at the highest point in order to aid venting. Counter flow connection shall be the preferred arrangement in order to obtain the maximum mean temperature difference.

Coils shall have a minimum of two rows and the maximum air passage velocity through the coil shall be 3.75m/sec. The maximum water pressure drop shall be 400Kpa.

Access panels shall be provided on either side of coil. Panels shall be in an accessible position and preferably on the larger duct dimension. Panel size shall be the maximum possible, commensurate with duct size.

6.5. Duct Mounted Electric Heating Coils

Electric heater coils shall consist of a number of heating elements mounted in a sheet steel casing. The elements shall be covered with a shielding material to prevent direct contact with the airflow and so installed that they can be removed for cleaning or renewal without dismantling the casing.

The surface temperature of the elements shall not exceed 150°C. The heater shall be arranged with the elements of the same number, or a multiple of the number of steps as the design control requires. All heaters of more than 3kW loading shall be balanced over three phases and the complete heater bank shall be arranged for balanced operation. The total resistance of the heater to airflow shall not exceed 3.75mm wg. The velocity through the area shall not be less than 1.75 m/sec and not to exceed 6.25m/sec.

Access panels shall be provided on either side of coil. Panels shall be in an accessible position and preferably on the larger duct dimension. Panel size shall be maximum commensurate with duct size.

The heaters shall include the following safety features:

a) Interlocked with duct air flow switch so that the heaters cannot operate unless the fan is running
b) High temperature cut-out device
c) Manual reset limit controls
d) Step sequence controller

6.6. Quartz Halogen Radiant Heaters

The quartz halogen radiant heaters shall come complete with individual low temperature thermostat, mesh guard and all appropriate mounting brackets.

7. WATER SYSTEMS

7.1. Heating, Chilled Water, and Domestic Hot Water Primary Circuit Pumps

Pumps shall be single stage, pipeline mounted, centrifugal pumps with a standard motor. The pumps shall have the following characteristics:

a) A cast iron pump base and pump head, complete with air vent
b) A stainless steel pump shaft
c) A bronze impeller, impeller nut and neck ring
d) Counter flanges
e) Standard seals

The pump may be installed in horizontal or vertical pipework, to suit pump manufactures requirements, but the shaft must never fall below the horizontal plane.

7.2. Domestic Hot Water Secondary Circuit Circulating Pumps

The domestic hot water, glandless, circulating pumps, shall be single stage in-line centrifugal pumps with a standard motor.

The pumps shall have the following characteristics:

a) Pump housing, with air vent
b) A stainless steel pump shaft
c) A bronze impeller, split cone, neck ring and rotor can
d) Counter flanges
e) All materials to be suitable for use in an open circuit application

The pump may be installed in horizontal or vertical pipework, to suit pump manufactures requirements, but the shaft must never fall below the horizontal plane.

7.3. Domestic Hot Water Calorifiers

The calorifier shall be a free-standing vertical unit with high grade stainless steel inner vessel surrounded by a mild steel primary water vessel. Maximum working temperature for the primary circuit shall be as stated elsewhere in this document. The maximum working temperature for the primary and secondary circuits shall be 90ºC and 70ºC respectively. A drainage connection, air release valve, appropriate safety devices, including a safety valve (with the discharge piped to a suitable location) and an inspection port shall be incorporated.

The vessel test pressures shall be a minimum of 1.5 times the working pressure.

7.4. Instantaneous Domestic Hot Water Heaters

The heaters shall be compact 3kW to 9kW units incorporating the following features:

a) Single on/off control and temperature selection
b) Adjustable stainless steel spray arm or interconnecting pipework to basins or sink units
c) High temperature thermostat safety cut-out. This device shuts off heater should water temperature exceed its normal design value.
d) Operation indicator lamp
e) The test pressure shall be 1.5 times the working pressure.
f) The unit shall come complete with all materials for installation and support.

g) Heating elements shall be the replaceable type. Internal surfaces shall be of a material that inhibits the format of lime scale.

h) Suitable for operation from a 400v/50Hz/3ph electrical supply.

7.5. Pressurisation/Expansion Units

The expansion vessels on hot water and chilled water pipe circuits shall compensate for all variations in system pressure. The units shall be capable of transmitting high and low pressure warnings to the HVAC control panel. Units shall be complete with all necessary controls to enable the system pressure to be maintained automatically and shall be sized for the system water volume and water temperature range.

7.6. Low Temperature Hot Water Radiators

The radiators shall be manufactured from cold rolled steel plate. They shall come complete with all appropriate wall-mounting materials, air vent, a lockshield valve and an appropriate individual thermostatic radiator valve for a reverse return pipework system.

7.7. Gas Fired Boilers

All gas fired boiler installation shall be sized on two boilers (minimum) each boiler at least 66% of the design load.

Floor mounted boilers are to be mounted on 150mm high (minimum) concrete bases.

Boilers shall be capable of operation using fuel gas at a maximum pressure of 0.5barg and shall be complete with all controls necessary for the completion operation of the boilers, including safety and operational controls.Sequencing control for multiple boilers is also required.

A gas shut off valve shall isolate the fuel gas supply to the boiler room upon excessive boiler temperature or by manual operation of a switch located within the boiler room.

7.8. Boiler Flues and Flues Dilution Systems

Boiler flues shall be of twin-wall construction where located external to building. The flues shall terminate in a suitable terminal.

Flue gases must be discharged at a location where they can be safely dispersed. Consideration is to be given to the effect of wind, the proximity of the building and the elevation of the flue discharge outlet.

Flues shall be capable of withstanding all relevant wind loading.

Where a flue is employed, the air pressure within the boiler house must not fall below the air pressure external to the boiler room. Boiler flue dilution systems must be separate from boiler room ventilation and boiler combustion air requirements.

Boiler flues and dilution systems are to be adequately supported and must include provision for boiler flue gas analysis.

Boiler flues and flue dilution systems shall have access panels at all necessary locations to ensure all parts of the system can be cleaned and inspected.

8. DAMPERS

8.1. Volume Control Dampers

Sufficient proprietary, manual, volume control dampers shall be installed in the ductwork air distribution system. Dampers shall be of the opposed blade type and shall be installed on all duct branches necessary to allow complete control over balancing of the system. Dampers manufactured by ductwork fabricators will not be accepted. All dampers shall be sufficiently rigid to prevent fluttering and air leakage past fully closed dampers shall not exceed 5% of the maximum design airflow in the duct. Each damper shall be fitted with a locking and position indicator device. These dampers are not be used as isolating dampers.

8.2. Duct Isolation Dampers (Air Shut-Off Dampers)

Frame and blades shall be manufactured from steel hot dip galvanised steel or heavy gauge aluminium. Seals of vinyl or polyurethane shall be provided at blade edges and all meeting surfaces to ensure complete closing of all blades.

Frame shall be low leakage type for all dampers.

Manual damper shall be fitted with a quadrant and operating handle of an approved type clearly marked with the damper position e.g., open, closed, operating. Motor controlled damper shall have an operating spindle or linkage for connection to the control mechanism and blade position shall be evident by visual inspection.

Each motor controlled isolating damper shall be complete with micro-switches, which shall indicate the damper in open and closed position or fault.The motorised control and isolating dampers shall be driven by the HVAC control system. It shall also be possible to manually drive each automatic damper.

When in the closed position, the leakage through and around the damper shall not exceed 0.05$m^3/s/m^2$ with a differential pressure of 1000Pa.

Damper shall be capable of accepting differential pressure of 4000Pa without distortion or buckling.

Any damper located within a below freezing environment shall be suitably trace heated to ensure satisfactory operation.

8.3. Fire Dampers

The fire dampers shall comply with NFPA 90A/UL and shall be tested and approved by an independent authority. Each fire damper shall have at least the same standard of fire resistance as the wall through which it passes. All dampers shall be of proprietary manufacture. Dampers manufactured by ductwork fabricators will not be accepted.

The fire damper casing shall be manufactured from1.6mm galvanised steel and the damper blade shall be mineral fibreboard with a metal sheet cover on both faces. Dampers shall be capable of either electrical or manual reset.

The blade shall be held open by an approved pattern fusible link set to operate at 72^{o}C, with the exception of units for use in a kitchen exhaust system, which shall be set to operate at 90^{o}C. The dampers shall be fitted with stainless steel spring, which shall ensure complete closure of the fire damper blade. The damper shall be provided with a position indicator. The fire dampers shall be provided with sub frames to aid damper installation into builders work wall openings and maintain damper stability under fire conditions.

Provision shall be made to provide easy access for maintenance.

8.4. Explosion Protection Dampers

Explosion protection dampers, as manufactured by Luwa Ltd or approved equal, shall be capable of withstanding all aspect of any blast to which they may be subjected. These are to include, but are not limited to:

- Blast let-through period
- Static and dynamic over and under pressures
- Temperature of air and any contaminants in the air
- Where necessary, support frames shall be provided, suitable for integration with the building fabric without comprising the design pressure rating. Dampers shall be fully accessible for regular maintenance.
- Blast details are as applicable to the building in which the HVAC system is to be installed.

9. GRILLES, DIFFUSERS, LOUVRES AND ATTENUATORS

9.1. Grilles, Diffusers and Air Transfer Grilles

Duct mounted supply air diffusers shall be manufactured from high grade extruded aluminium and come complete with opposed blade damper and plenum box. The maximum air velocity at the neck of the diffuser shall be 3m/s.

The core shall be removable to allow easy access to the opposed blade damper and for fixing the diffuser to the ductwork.

Diffusers shall be fixed by means of slip joint formed between the diffuser body and the ductwork and secured by means of self-tapping screws.

Supply and return air grilles shall be manufactured from high grade extruded aluminium. The grilles shall be equipped with opposed blade damper adjustable by means of a key through the face of the grille.

Transfer grilles shall be of the fixed blade non-vision type manufactured from high grade extruded aluminium. The maximum pressure drop for any single application, using a single or a pair of grilles in series, shall be 50Pa.

Grilles shall be fixed through the face of the grille border by means of countersunk bolts, nuts and washers.

Grilles and diffusers shall be fitted with non-combustible and smokeless sealing strip behind the face, which shall form an airtight seal.

Care shall be taken when selecting supply air grilles and diffusers to ensure that the throw and terminal air velocity are compatible with the location in which the diffuser shall be installed and the nature of the zone occupancy. The selection of supply diffusers and return or exhaust air grilles shall respect the noise criteria in the space in which they are located. All Noise Ratings (NR) shall be at least 5 dBA below the design value for the room concerned.

Where mesh inlet guards are required on exhaust air intakes, these shall be of 2mm minimum thickness galvanised steel wire mesh construction with a 15mm mesh opening.

9.2. Fresh Air Intake and Air Exhaust Louvres

External louvres shall be manufactured from high grade galvanised steel and shall come complete with a galvanised steel bird mesh screen. For areas where inlet located at up to 5m height, air intake louvres shall incorporate a sand trap louvre designed for a face velocity of 1m/sec. For areas where inlet located at 20m height, protective steel bird mesh screen and louvre shall be installed.

9.3. Sound Attenuators and Sound Insulation

The purpose made Attenuators shall be proprietary units shall be installed where required in the Air Handling Units and/or the ductwork systems to ensure that the specified noise criteria are not exceeded. The attenuators shall be so designed and installed in the ductwork that they offer low resistance to airflow, have adequate strength and cohesion to resist erosion by air and do not produce dust. They shall be free from odour and proof against rot, damp, mould growth and vermin and shall comply to the relevant conditions with regard to fire and smoke Air flow through attenuators shall not generate noise. Attenuators shall be capable of storage in any position without causing sagging of the sound absorbent internal media.

10. VALVES AND STRAINERS

10.1. Three Way Control Valves Serving Heating Circuits and Domestic Hot Water Primary Circuits

The valve sizing data and knowledge of the system pressure drop utilised by the SUPPLIER shall be combined in order to correctly select control valves with appropriate valve authorities.

The preferred location of a control valve shall be on the return from a heater exchange coil diverting the fluid flow with respect to the coil. In this application, valve authority shall be between 0.3 and 0.5.

All control valve bodies should be properly supported and the pipeline so designed and installed that no distortion of the valve body can occur. Care should be taken to ensure that the actuating gear or spindle is in the correct plane.

10.2. Butterfly, Gate, Globe, Check and Ball Valves

Please refer to COMPANY Specification KPO-00-PIP-SPC-00003-E (Piping Material Classes):- Pipework classification A13, for heating and chilled water, A22 for potable water.

10.3. Strainers (not included in appropriate COMPANY Piping Material Classes)

These bronze ‘Y’ type strainers shall incorporate a stainless steel 0.75mm mesh strainer element and screw-in cap. If required to serve a control valve, the mesh size shall be compatible with the control valve manufacturers requirements.They shall have tapered thread connections and test points. Valves to be suitable for a minimum temperature of -45^{o}C.

10.4. Fixed Orifice Flow Measurement and Double Regulating Valves (not included in appropriate COMPANY Piping Material Classes)

These bronze valves shall conform to the requirements of BS 7350:1990 or other internationally acceptable standards in respect of all design and performance requirements. They shall have tapered threads and shall be installed with the correct lengths of straight pipe upstream and downstream.

Accuracy shall be within ± 10% of the design water volume.

Valves to be suitable for a minimum temperature of -45^{o}C.

10.5. Draw Off Ball Valves (not included in appropriate COMPANY Piping Material Classes)

These quarter turn, lever operation, bronze ball valves with hose union shall have tapered threads and shall be suitable for a minimum temperature of -45^{o}C.

10.6. Test Points

Pressure indication and temperature indication points shall be as COMPANY Specification KPO-00-INS-SPC-00009-E, General Instrument Specification.

10.7. Manual Gas Shut Off Valves

Please refer to COMPANY Specification:- KPO-00-PIP-SPC-00003-E, pipe class A13.

11. POWER CONTROL SYSTEMS

11.1. HVAC Control Panel

Where possible, the HVAC control panel shall be located within the HVAC plant room and shall include, but shall not be restricted to, the following fascia mounted items:

- Hand-off-Auto selections
- System No. 1 - System No. 2
- Panel live lamp
- Lamp indicating automatic HVAC System changeover due to failure of duty electrical feed (applies to dual feed applications only).
- Refrigeration system fault lamp

- Dirty filter lamp (1 lamp serves all filters)
- Building low pressure lamp (as applicable)
- Panel lamp bulb integrity test facility
- Panel isolation switch
- Fan, Pump, AHU and Refrigeration Unit run and trip lamps
- Fire damper closed lamp (1 lamp serves all fire dampers)

The panel shall include all motor starters, wiring and control hardware items.

11.2. Fire and Gas System Interface

Each HVAC system shall interface with the building fire and gas protection system. The fire/gas system output will feed a volt free contact rated for 24v d.c. located on the HVAC control panel. The HVAC systems shall be capable of performing the following general functions on receipt of a signal.

- Shut down HVAC plant.
- H_2S gas detection signal shall close inlet/exhaust, gas tight dampers and run HVAC plant on full recirculation. External HVAC plant to be isolated if required.
- Initiate emergency ventilation systems within buildings rated as hazardous.

11.3. Fireman's Panel

Manually operated, fireman's switches shall enable on/off control, over the exhaust air fan units in the event of a fire. The switch shall be located within an enclosure positioned within a non-classified non-hazardous area.

11.4. Equipment Failure/General Alarm

The HVAC control panel shall be provided with the following 24v dc, volt free contacts;

- A common alarm for any fault relayed to the HVAC panel.
- System healthy.
- Battery extract ventilation failure. On loss of airflow, the Fire and Gas system shall trip the boost charge facility.

11.5. Control Panel Construction

The following details apply to panels located in locations protected from the weather. Externally located panels shall be vendor standard, subject to the approval of the COMPANY.

The control panels should be metal enclosed, flushed faced, to all enclosed, free standing and/or subject to size, wall mounted and suitable for 'back to the wall' fixing.

The control panels should be constructed from Zintex sheet of welded construction, which shall be 100% seal welded penetration, free from slag inclusions. All welds shall be fully cleaned and free from burrs on completion. There shall be no gaps or openings permitted.

Holes and cut-outs shall be cleanly drilled or cut. No gas cutting processes shall be employed. All holes including label fixings shall be drilled to installation of equipment.

Provision shall be made from cables to enter through a removable gland plate from the top of the panel, unless the panel is located in any area served by a building deluge system, in which case entry shall be from the underside of the panel. For bottom entry panels, adequate space shall be allowed below the panel for cable bend radii etc.

After steelwork assembly all welds shall be ground flat and the surface ground to provide and adequate key for painting. The following procedure shall be followed:

- All surfaces shall be degreased and rust or scale removed
- Stopping and filling shall be applied and the surface sanded down to give a smooth finish
- Two primer filler coats shall be applied, flash off and stove, apply stoving stopper and rub down
- The final finish shall comprise two coats, flash off and stove to provide a hard smooth finish
- Colour - RAL7032

Access to the inside of the panel enclosures shall be via hinged doors with minimum of 2 latch points provided on each door. Where double doors are necessary, they shall close on to fixed central post arrangement with suitable seals to maintain the IP rating of the panels

All doors and access panels shall be provided with gaskets.

The total panel enclosure shall conform as a minimum to the degree of protection listed in clause 1.2 of this document.

11.6. Control Panel Requirements

The types of panel to be employed are as follows. The applications of these panels to the various building HVAC systems are detailed in COMPANY Specification KPO-00-HVA-SPC-00003-E.

2 No. power feeds entering panel, with only one power feed live at any one time. Panel shall be complete with duplicate power packs. 2 No. 100% duty (i.e. Run and Standby) drives are to be served, one power pack shall serve all No. 1 drives and the other Power pack shall serve all No.2 drives. Any changeover of power supply shall be carried external to and upstream of, the HVAC panel.

- 2 No. power feeds entering panel, with only one power feed live at any one time. Panel shall be complete with duplicate power packs. 2 No. drives are to be served, one power pack shall serve all No 1 drives and the other Power pack shall serve all No 2 drives. One set of drives shall be for use with the normal electrical power feed and shall give 100% duty and the other set of drives shall be for use with the emergency electrical power feed and shall power a reduced number of drives. Any changeover of power supply shall be carried external to and upstream of, the HVAC panel. As the HVAC panel cannot recognise if it is being supplied with a normal or an emergency supply, the electrical equipment responsible for the changeover shall send a signal to a pair of volt free contacts on the HVAC control panel so that the panel can activate the appropriate equipment.

- 1 No. power feed entering panel. Panel shall be complete with a single power pack. A single set of drives is to be served.

A power supply fault alarm shall be provided on each panel with an input to the panel's common alarm relay. The supply to the field devices shall be 24V DC generated from the panel. Any other voltage required shall also be generated from within the panel.

All internal wiring shall be in PVC insulated, stranded copper, conductors 600/1000 V grade. Cable shall be in accordance with COMPANY specification KPO-00-ELT-SPC-00018-E – Electrical Requirements for Packaged units.

Flexible cables shall be used for wiring equipment in doors an shall be arranged so that it is not possible for wiring to be trapped by door environment.

The wiring shall be loomed together, wrapped with flexible PVC coil for protection and be firmly clamped at both ends to prevent removal at terminations.

The wiring within the control panel shall be securely held in position, either loomed or run in conduit trunking. The layout shall permit alternations to the circuits without requiring shutdown.

Wiring identification shall be by numbering and/or lettered ferrules of insulating material adjacent to the terminals. All terminals on hinged panels shall be fully shrouded.

All wiring for external connections shall be brought to individual terminals on a readily accessible terminal block. Terminal blocks shall include 25% spare ways.

Circuits and terminals operating at different voltages and/or performing different functions shall be adequately segregated or barriers fitted.

All terminal blocks shall be rail mounted and located at the top of the panel for top entry field cables, and at the bottom of the panel for bottom entry field cables.

In all cases, sufficient room must be allowed between terminal blocks and glands. Cables must not impede access to rack mounted equipment. Others shall allow adequate clearance, for cable entry terminations.

Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers etc. and provide easy access for terminating cables.

All terminal blocks shall be clamp type (Weidmuller Ref. No. SAK-C4 for field/panel termination and SAK-2.5 for internal panel termination or equal) shrouded or provided with transparent covers. Pinch-screw type terminals are not acceptable. All wiring shall be terminated with spade terminals, with no more than two wires per terminal.

All terminal circuits shall be adequately protected by means of switches and fuses and comply with the following requirements:

a) All metallic non-current carrying parts of the control panel shall be bonded together and connected to the control panel earth busbar

b) All doors shall be bonded to main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed

c) The cable gland plates shall be bonded directly to the earthing busbar by means of cable.

11.7. HVAC Control Systems

The control systems shall be electronic and be capable of performing all functions briefly described herein and that necessary to provide fully satisfactory interval conditions and operating systems.

Each control element shall incorporate means of adjustment of the desired value of the controlled conditions. Thermostats and humidistats, which are readily accessible, shall be protected to prevent unauthorised interference.Control equipment shall be sited in accessible positions and access doors shall be provided adjacent to motorised dampers. All sensing elements should be located so that they measure truly representative conditions.

All instruments, such as thermostats, humidistats and pressure detectors, should be securely fixed in position free from vibration and risk of mechanical damage. Thermostats and humidistats should be installed to avoid undesirable effects of extremes of heat, cold, dust or moisture. Where this is not practicable, protection shields should be fitted around the sensitive elements,

Arrangements should be made to ensure free fluid flow over the instrument wherever necessary for correct operation.

Duct-insertion type thermostats and humidistats should have the sensing elements correctly positioned in the air stream, adequately supported and located where not subjected to radiation from heating coils.

Liquid immersion thermostats should be fixed with the maximum length practicable immersed in the moving liquid and where possible in line with the direction of flow.

Where possible, controllers and other items requiring adjustment or maintenance should be mounted approximately 1.5m above floor level. All controllers, sensing elements and control devices should be easily accessible, and when any of these items are installed within an air system, it is essential that proper access doors be provided.

11.8. Fiscal Metering of Electricity used for Building Heating Purposes

Where required by the Contract Documentation, HVAC Control/MCC panels shall be provided with all necessary current transformers, terminals and components to enable the installation of a kW hour run meter. The meter would be remote to the panel and would not form part of the HVAC Scope of Work.

Should a meter be specified, all HVAC power and instrumentation circuitry shall be designed for the monitoring of the HVAC electric heating circuits.

12. COMMISSIONING AND TESTING

12.1. General

This section covers balancing and testing of all HVAC equipment and duct systems, including pre-installation inspection, testing and adjustment of control system, testing and start-up of equipment and post contract completion test.

SUPPLIER shall provide full details for installation, site testing, commissioning and start-up of the equipment as specified in the 'Supplier Documentation Requirements Listing (SDRL) listed in the Material Requisition document.

SUPPLIER shall provide a site performance test procedure which shall be agreed upon by all parties involved prior to the commencement of the test. The procedure shall include as a minimum, the parameters to be measured and the duration of the test for complete HVAC system.

Balancing, adjusting, and testing shall be witnessed by the COMPANY or by COMPANY appointed representative (AIA).

Final Inspection and Final Acceptance Testing is required to all control panels and Motor Control Centres.

Any equipment, systems, or work furnished by the Supplier and found deficient during any tests shall be replaced or revised as required by the SUPPLIER to the satisfaction of the COMPANY and at the SUPPLIER'S expense.

12.2. Codes and Standards

The following standards or their internationally accepted equivalent, will be considered to define the best practices of the trade and shall be referenced, where necessary, to cover details or alternate methods of procedure. They are published by the Chartered Institution of Building Services Engineers.:

i) Commissioning Code Series A - Air Distribution Systems - High & Low Velocity
ii) Commissioning Code Series R - Refrigeration Systems
iii) Commissioning Code Series C Automatic Controls
iv) Commissioning Code Series W - Water Distribution Systems

12.3. Testing and start-up

Each piece of equipment shall be started and operated under load to demonstrate that it is capable of fulfilling its design functions. Direction of rotation shall be checked on each piece of rotating equipment. Precautions shall be taken to protect systems when starting at sub-zero temperatures, including protection of filter media and water systems.

12.4. Testing and Adjusting of Control Systems

Prior to and during the completion tests, a suitably qualified representative of the Vendor shall check and properly adjust the set points of each device in the HVAC control system to ascertain that each piece of equipment is at the correct operating condition. This requirement is in addition to any other requirements that maybe required by the project documentation.

12.5. Air, Refrigeration and Water Balancing and Commissioning

The SUPPLIER, or a suitably qualified representative of the SUPPLIER, shall furnish all equipment required to accomplish the balancing, adjusting and testing of all HVAC Systems.

All test instruments shall be tested and recalibrated as necessary within the time limits imposed by the manufacturer. The date of the above testing/recalibration shall make due allowance for the period of usage of the instrument.

Copies of the recalibration certificates shall be forwarded to the COMPANY at least 7 days before the instrument is to be used.

12.6. Completion Tests

Upon completion of the HVAC work, or at such time prior to completion as may be determined by COMPANY, all HVAC equipment and systems shall be operated and tested for two 8-hour periods, to the satisfaction of the COMPANY'S Representative. Systems shall be run on both heating and cooling cycles where applicable. All commissioning and test data shall be submitted to and accepted by, the COMPANY. This requirement is in addition to any other requirements that maybe required by the project documentation.

12.7. Acceptance

Any portion of work, which fails to function as required, or any defects of equipment and accessories furnished by the SUPPLIER at his expense, and the affected system shall be tested again.

A complete record of all tests and their results shall be provided by the SUPPLIER and turned over to the COMPANY'S representative at the conclusion of the completion test.

The tests shall commence after balancing and adjustments to equipment and systems have been completed.

Immediately before starting tests, all air filter media shall be cleaned or renewed. This requirement is in addition to any other requirements that maybe required by the project documentation.

13. ACCESS TO EQUIPMENT

Sufficient access and working room shall be provided around all equipment and areas where routine maintenance, adjustment and other operations have to be performed. Local safety requirements shall be complied with, especially with regard to access to electrical items.

Gas Fired Boilers and associated Plant shall be located within dedicated boiler rooms.

The boiler rooms shall:

a) Allow full maintenance and removal of the equipment housed within the boiler room, including any boiler tube replacement activities

Where access is required on roofs, adequate walkways and working areas shall be provided.

14. EQUIPMENT NAMEPLATES

All equipment shall be complete with securely fixed nameplates in English and Russian Languages.

Information contained on nameplates shall be as detailed in the COMPANY'S purchasing documentation.

15. PRESERVATION

Before taken into use equipment and systems shall be preserved in accordance with Company procedure KPO-00-LGT-SPC-00001-ER, 'Preservation of New Equipment During Transportation and Storage'.

16. DOCUMENTATION

Company documentation requirements are detailed on the VDRL attached to the Material Requisition. The Supplier is required to add submission dates to this form and agree, contractually, to meet these submission dates.

APPENDIX I

BCH-21-77: Instructions for the design of the heating and ventilation of oil refining and petrochemical enterprises.

VNTP 3-85 - Technological Design Standards. Objects Of Collection, Transportation, Preparation Of Oil, Gas And Water Of Oil Fields

CN RoK 4.02.-01-2011 - Construction norms. Heating, ventilation and air conditioning.

SoR RoK 4.02-101-2012 – Set of Rules. Heating, ventilation and air conditioning.

RDS RoK 2.02-11-2001 - Design Principles for Fire Safety of Facilities at Karachaganak Oil And Gas Condensate Field

Institute of Petroleum:

“Model Code of Safe Practice” Part 15

American Society of Heating Refrigeration and Ventilation Engineers (A.S.H.R.A.E).

BS EN378 - Specification for refrigeration systems and heat pumps- Safety and Environmental requirements.

BS 5422-1990 edition, BS 3927 - 1986 edition Table 1 and applied in accordance with BS 5970 Pipework Insulation.

Heating and Ventilation Contractors Association - (United Kingdom) specification for low velocity ductwork systems DW/142.

I.S.A. (Instrument Society of America).

The fire dampers shall comply with NFPA 90A/UL [Note: U.S. Code].

The following documents as published by the Chartered Institution of Building Services Engineers (C.I.B.S.E.):

v) Commissioning Code Series A - Air Distribution Systems - High Low velocity (current edition)
vi) Commissioning Code Series R - Refrigeration Systems (current edition)
vii) Commissioning Code Series C - Automatic Controls (current edition)
viii) Commissioning Code Series W - Water Distribution Systems (current edition)