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9 ACCESSORIES

9.1 GENERAL

9.1.1 Scope

- 1 This Part details the requirements for accessories that are to be included as specified in the Project Documentation.
- 2 For voltages and frequencies, regulations and requirements of Kahramaa and relevant authorities should be taken into account.
- 3 Related Sections and parts are as follows:

This Section

Part 5 Chilled Water Pipework

Section 1 General

Section 10 Instrumentation control and Automation

Section 21 Electrical Works

9.2 SOUND AND VIBRATION CONTROL EQUIPMENT

9.2.1 General

- 1 The noise produced by the installation in the spaces served, in adjacent buildings and in the open air surrounding plant rooms shall be kept as low as possible. This shall be specially considered in the selection of fans (including those for condensers and cooling towers), motors fan coil units and terminal units, grilles and diffusers and the internal finish and arrangements distribution ducting.
- 2 All plant and equipment shall be isolated in such a manner that noise and vibration is not transmitted through the structure.
- 3 Anti vibration equipment will be manufactured by a specialist company acceptable to the Engineer with standard ratings information available.
- 4 All necessary provisions shall be included to reduce the noise level of all plan and equipment to the required level detailed in the QGEWC regulations.

9.2.2 Silencers

- 1 All silencers shall be fitted with drilled angle flanges to suit the adjacent plant.
- 2 The method of installing the acoustic elements in the casing shall not cause air leaks.
- 3 The acoustic elements shall incorporate full aerodynamic leading and trailing edges (not square ends).
- 4 The acoustic material installed in the element shall be inert, rot and vermin proof, non-hygrosopic, non-combustible mineral wool or glass fibre acoustic medium.
- 5 The acoustic material shall be packed to a density of not less than 48 Kg/m³ and retained by a perforated steel sheet facing and fine membrane to stop the acoustic material contaminating the system air.
- 6 Where required for water or grease laden duties an impervious but acoustically transparent membrane shall be fitted behind the perforated metal facing.

- 7 The silencer units shall be delivered to site with blocked ends to prevent the ingress of debris during installation and storage to reduce the risk of damage.
- 8 The silencers shall be constructed of heavy gauge steel and shall match the adjacent ductwork. Galvanized silencers shall not be used in stainless steel ductwork etc.
- 9 The silencers shall be factory manufactured and technical data submitted and approved in advance of ordering the units. The technical data shall include both the acoustic and aerodynamic performance.
- 10 Where a silencer is made under licence or part assembled locally, tests must be made after assembly and witnessed by an independent authority.
- 11 The static pressure loss of all silencers required shall be considered in all handling equipment original selection.

9.2.3 Anti-Vibration Mountings

- 1 All dynamic machinery shall be isolated from the building structure by vibration isolators and/or vibration isolation materials which shall be specifically designed and selected to suit the machinery for which it is to be used.
- 2 Spring anti-vibration mounts.
 - (a) each mounting shall consist of a telescopic top and bottom housing containing one or more helical steel springs of 50 mm minimum diameter as the principle isolation elements
 - (b) the bottom plate shall be fitted with a 6 mm thick neoprene pad bonded to it to reduce high frequency flaming
 - (c) when used with equipment having a fluid weight in excess of 25 % of the total empty equipment weight a suitable hold down or restrained shall be incorporated
 - (d) the mounting shall incorporate a built in levelling device and resilient inserts as guides for the upper and lower housings.
 - (e) all spring mounts shall be designed such that the lateral spring stiffness is equal to the vertical stiffness
 - (f) the spring mounts shall be selected for all items of plant with stiffness to cater for any eccentric weight distribution over the unit base
 - (g) an equal static deflection shall be provided on all mounts to avoid the possibility of flanking caused by the plant tilting and rendering one or more of the mounts solid.

9.2.4 Resilient Hangers

- 1 Resilient hangers shall be of the two element design with helical spring and neoprene in - shear element.
- 2 The elements shall be mounted in a steel section pre-drilled and tapped at the top and bottom to receive threaded hanger rod.
- 3 The resilient hanger shall be located so that they are vertical.

9.2.5 Rubber or Neoprene Mounts

- 1 The mounts shall consist of a steel top plate and base plate completely embedded in colour coded neoprene for easy identification of rated load capacity.
- 2 The mountings shall be moulded with non-skid ribbed construction on the top plate and base plate.
- 3 The mountings shall be equipped with bolt holes in the base plate and tapped holes in the top plate so that they can be bolted to the floor and equipment when required.

- 4 Plant and equipment as detailed in the QGEWC regulations shall be installed on anti-vibration units in the form of multi-layer rubber pads.
- 5 Multi-layer pads shall compose of rubber sheets with square grid pattern on both sides and steel insert sheets of 1.4 mm. The composite pad thickness shall be selected the suit the equipment but shall not be less than 32 mm.

9.2.6 Concrete Inertia Base

- 1 The concrete inertia base shall be constructed of an all welded steel framework.
- 2 Height saving brackets shall be welded to the framework to install the anti-vibration mounts.
- 3 The frame depth shall be approximately $1\frac{1}{2}$ the longest dimension of the equipment, with a minimum depth of 150 mm.
- 4 The bottom of the frame shall be blanked off and concrete ($2,300 \text{ kg/m}^3$) poured over steel reinforcing rods positioned 35 mm above the bottom.
- 5 The total weight of the base shall be at least 1.5 times the total equipment weight.
- 6 Concrete inertia bases for split case pumps shall be extended in width to allow for provision of supports for suction and discharge elbows.
- 7 When complete with the equipment installed checks shall be carried out to ensure that a positive air gap is present between the inertia base and floor.

9.2.7 Plate Bases

- 1 Where required equipment shall be mounted on anti-vibration rails or steel plant bases.
- 2 The anti-vibration rail shall comprise of steel beam with height saving brackets at each end.
- 3 The steel plant bases shall comprise of an all welded steel framework to support the equipment. This may form a composite A.V. rail.
- 4 The A.V. rails or steel plant bases shall be sufficiently rigid to provide adequate support for the equipment and prevent undue strain on the equipment.

9.2.8 Acoustic Louvers

- 1 All acoustic louvers shall be designed to reduce the airborne noise of plant down to minimum ambient levels with an air velocity not exceeding 3.0 m/s.
- 2 The louver aerofoils shall be constructed of perforated galvanized mild steel sheet and packed with a fibre acoustic medium as specified for silencers.
- 3 The complete unit shall be supplied complete or in sections with a galvanized mesh bird screen.
- 4 The unit shall be provided with all necessary fixing holes and lugs for location within a builders work frame.
- 5 The external finish of the unit shall be approved by the architect to match other finishes.

9.3 INSTRUMENTS AND GAUGES

9.3.1 Pressure Gauges

- 1 The pressure gauges shall be 100 mm diameter stainless steel case with black figures on a white background. The movement shall be stainless steel or phosphor bronze with rotary type movement and bourdon tube.

- 2 Where the line size is 100 mm or less the gauge is to be installed into a T-branch with reduces. For pipe sizes above 100 mm a “threadolet” weld on connection may be used subject to proper procedures and requirements of the Clause 1.1.17 of Part 1 of this Section.
- 3 The gauges shall be mounted using a mild steel syphon and brass gauge cock.
- 4 The range of the gauges shall be selected such that the operating point is almost midway of the selected range.
- 5 Where gauges are to be mounted separate from the equipment to which they relate a gauge board shall be used. The gauges shall be fixed to resiliently mounted gauge boards with each gauge identified by a permanently fixed label
- 6 Where pressure gauges are mounted on the suction and discharge of pumps the gauges shall be connected to the tappings on the pumps when provided.
- 7 Pressure gauges shall be installed to monitor the pressure at the following locations.
 - (a) pump suction and discharge
 - (b) chiller flow and return connections
 - (c) AHU flow and return connection
 - (d) heat exchange flow and return connections.

9.3.2 Thermometers

- 1 Wet service thermometers shall be straight shank coloured mercury filled insertion type. They shall have a stem length of 80 mm and a scale length of 225 mm, and the capability of adjusting the angle of the scale to the stem. Copper or brass separable well shall be provided for each thermometer.
- 2 Air service thermometers shall be straight shank coloured mercury filled insertion type. They shall have a stem length of 150 mm and scale length of 225 mm, and the capability of adjusting the angle of the scale to the stem.
- 3 The thermometers shall be graduated in °C with 2 °C divisions.
- 4 Where the temperature of equipment is to be monitored remotely, remote reading vapour actuated thermometers shall be used. The thermometer shall have a stainless steel case and phosphor bronze movement with 100 mm dial diameters with flush type back outlet. The connecting tube shall be double braided bronze armour over a copper capillary and copper bulb.
- 5 Where thermometers are to be mounted separate from the equipment to which they relate a gauge board shall be used. The gauges shall be fixed to resilient mounted gauge boards with each gauge identified by a permanently fixed label.
- 6 Thermometers shall be installed to monitor the temperature at the following locations:
 - (a) chiller flow and return connections
 - (b) AHU flow and return connections
 - (c) heat exchangers flow and return connections.

9.3.3 Dial Type Thermometer

- 1 The thermometers shall be 100 mm diameter vapour pressure type.
- 2 The casing and movement shall be non-ferrous material
- 3 The dial shall be white with black numbering

4 Dial type thermometers shall be installed as indicated in the Project Documentation.

9.3.4 Manometers

- 1 Incline or vertical manometers shall be plastic or metal construction. They shall be filled with coloured fluid to indicate the pressure being measured and have a zero adjustment for calibration.
- 2 The manometer shall be suitably sized for the pressures to be monitored.
- 3 The manometers shall be located in an accessible position so that the pressure can be recorded.
- 4 The tubing shall be neatly fixed and protected from damage when required.
- 5 Manometers shall be installed across all filters and the clean and dirty pressures shall be clearly identified.

9.4 CONTROL SYSTEMS

9.4.1 General

- 1 The Contractor shall include in his tender for an Automatic Control System to be supplied and engineered by a specialist controls supplier (SCS). In his choice of SCS, the Contractor must ensure that all systems to be supplied are fully and exactly compatible with the Project Documentation. The SCS shall be responsible for the entire control system. He shall allow for the supply, installation and commissioning of all items and materials necessary to achieve the control functions defined in this section and elsewhere in the Project Documentation. Subject to the Consultant's approval, control systems may also be supplied by the manufacturer of the equipment being controlled. Such manufacturer will be subject to the same terms and conditions as the SCS.
- 2 The SCS, as a specialist, will be aware of, and will include for any special services or conditions arising from any equipment to be supplied by the Contractor, whether the originally specified item or any proposed and approved alternate.
- 3 When the SCS staff are on site they shall work in close harmony with all other trades and shall assist other Subcontractors in works associated with the overall control system installation.
- 4 The SCS shall include in his costs for the preparation of all drawings, manuals, record drawings and labels as specified. He shall allow for the regular attendance on site of a qualified Engineer to provide technical liaison during the currency of the installation and ensure complete testing, commissioning, cleaning, making good and handing over of the works as detailed in this section.
- 5 The entire control system shall be complete with all necessary control devices, thermostats, valves, motors, relays, switches, dampers, panels, low voltage wiring, electronic components, etc., to provide the functions as described in this specification, or required, whether specifically mentioned or not. All controls shall be the product of one manufacturer, unless otherwise approved in advance.
- 6 The control system shall be installed or supervised complete in all respects by competent mechanics, regularly employed by the manufacturer of the control system.
- 7 All automatic control valves and dampers shall be manufactured by the control manufacturer or as otherwise specified and shall be installed in pipelines and ducts by the respective trade under the supervision of the control manufacturer. All electric wiring in connection with the control system shall be installed as hereinafter detailed.

- 8 Complete drawings shall be submitted to the Consultant for approval before any field installation is started. Such drawings shall give complete descriptions of all control elements and shall show complete schematic wiring diagrams including functional description. Drawing shall indicate specifically the type of finish of all room exposed controls, and such finish shall be subject to the Consultant's approval.
- 9 Any descriptive parts of this specification shall be considered complimentary to detail requirements for types of equipment. Any quantities noted are approximate and must be measured by the Contractor before bidding.
- 10 Verification systems shall be interlocked with the fire alarm system as specified and as required by the Local Authority and all necessary control and interfacing devices shall be provided after fully co-ordination with fire alarm system controls.
- 11 Automatic control systems may be of the electromechanical or electronic type as described in the Project Documentation. Unless otherwise specified control systems shall be energised as follows:
 - (a) electric Control Systems 110 or 240 volts.
 - (b) electronic Control Systems - Standard 24 volts

The installation may be a single system or a combination of systems.
- 12 All control equipment including all control valves, dampers and actuators shall be selected sized and rated to suit the application and operating conditions of the systems in which they are installed to provide stable and repeatable performance of the systems being controlled.
- 13 All items of control equipment shall be compatible within any system, between systems and with controlled equipment.
- 14 All items of control equipment shall be sited such that access for adjustment and maintenance purposes is not impeded. However, where items of control equipment are mounted in accessible positions within normally occupied area, the control items shall be provided with secure tamper proof enclosures to prevent unauthorised interference.
- 15 Control system shall be arranged such that, in the event of electrical power failure or other abnormal operating conditions, inherent fail-safe features are provided to equipment and systems to prevent potentially hazardous conditions arising.
- 16 The sensitivity of sensors and the speed for response of actuators shall be selected for complete compatibility with the system application requirements.
- 17 All control components shall be of high quality, low risk rate and of long term reliability for both continuous and intermittent use and shall maintain accuracy and high repeatability of commissioned performance.
- 18 Where equipment requires less than 240 volts supply, all necessary voltage transformers shall be provided either separately or integrated with the various packaged equipment. Equipment requiring DC supply shall be provided with all current rectifiers and shall be suitable for the connected loads.
- 19 All controls shall be compatible with the existing building management systems when the system is an extension of an existing system.

9.4.2 Temperature Humidity Sensor and Controller

- 1 All temperature sensors shall be semiconductor type with NTC sensing element and shall have suitable range of operation i.e. 0 to 30°C. 20 to 105°C. etc. The housing shall be plug-in type with terminals on the base plate enabling the wiring without disturbing the sensor. The sensor shall be field wired using a unscreened cable to a base plate.
- 2 The temperature sensor shall have a tolerance of $\pm 1^{\circ}\text{C}$ and a fast response time.
- 3 Elements sensing liquid temperature in pipework shall be:
 - (a) provided with means for withdrawal for calibration, servicing etc., without the need for draining the system
 - (b) positioned so that the active part of the element is wholly within the liquid;
 - (c) positioned so that the element is not less than 12 pipe diameters downstream from a point of mixing.
- 4 Elements sensing the temperature of air in a duct shall be positioned so that:
 - (a) the element is not subject to radiation
 - (b) account is taken of temperature stratification, (i.e. positioning for high temperature limit sensing, positioning for average temperature sensing)
 - (c) if of the capillary averaging type, it is installed on a suitable framework and is suitably arranged for servicing
 - (d) if used for determining the dew point and the air adjacent to the element is known to be saturated within acceptable limits, the construction and material of the element shall be compatible for use in moist air.
- 5 Elements sensing the temperature of a solid surface shall be positioned and fixed so as to give good thermal contact.
- 6 The precise location of site elements sensing the temperature of a room or other such space in a representative position shall be approved by the Engineer.
 - (a) where indicated it shall be at a height of approximately 1.7 m above floor level (when fitted in a room);
 - (b) in the return air path where indicated.
- 7 Room thermostats for FCU shall include a temperature set point with a remote sensor installed in return air duct work or as an integral part of the controller as specified a 3 speed switch for fan speed control and a fan-off-cool switch.
- 8 Humidity sensing element positions shall be:
 - (a) representative of the space in which the humidity is being measured
 - (b) such that the air velocity is within the range required by the sensing element
 - (c) arranged to ensure that the air reaching the elements is free from airborne contaminations.
- 9 Basically all sensing elements shall be correctly located strictly in accordance with the manufacturer as recommendations.

- 10 All controllers shall be fully proportional type with proportional band of upto 10 °C. The dead zone between the stages shall be adjustable upto ± 5 °C. The controllers shall be of plug in type construction and shall be designed for removal from the pre-wired bases without disturbing the wiring. The electronic circuit shall amplify the deviation of the sensor signal from the setpoint on the controller to produce a fully proportional signal to modulate the controlled device such as three (3) way control valve etc.

9.4.3 Control Valves

- 1 All control valves shall be selected and sized by the controls equipment manufacturer and shall be suitable for the systems application and operating conditions.
- 2 Unless otherwise stated valves shall be of the modulating type with adequate rangeability, having equal percentage or power linear characteristics.
- 3 Valves shall be provided with the following minimum valve lifts:
 - (a) valves up to 25 mm in size shall have a minimum lift of 8 mm
 - (b) valves of 32 to 50 mm in size shall have a minimum lift of 12 mm
 - (c) valves up to 65 mm in size shall have a minimum lift of 20 mm
- 4 Valve authorities shall generally be in the range of 0.3 to 0.5 but compatible with economic valve pressure drops sufficient to provide adequate control without promoting cavitation.
- 5 Actuators on all valve shall be capable of opening and closing the valves against the maximum system operating pressures,
- 6 All valves, other than on terminal units such as fan coil units shall be provided with external position indicators. They shall be complete with actuators, mounting brackets and all necessary auxiliary switches.
- 7 Seats and stems shall be removable and of stainless steel, except where alternative seating material is necessary to provide tight shut-off.
- 8 Valves upto 50 mm shall be of bronze bodies construction with stainless steel trim.
- 9 Valves of 65 mm size and above shall be of cast/nodular iron or steel bodies construction as suitable for the pressure and temperature conditions having stainless steel trim.
- 10 The copper content of alloy valves shall be as high as possible to avoid dezincification.
- 11 All valves shall be embossed with the manufacturer's logo, valve size and direction of flow.
- 12 Valves, shall be provided with clutch or lifting mechanism to enable valves to be controlled manually in the event of power source failure.
- 13 Unless otherwise specified, control valve actuators for chilled water coils shall be fitted with spring returns to the safe position on failure of electrical supply, to provide necessary plant protection shut-off or relief conditions to systems or equipment.

9.4.4 Motorized Control Dampers

- 1 Control dampers and actuators shall be selected and sized to provide the desired power and performance characteristic in accordance with the control equipment manufacturer's recommendations,
- 2 All damper shall be provided with a heavy duty and rigid mounting bracket and all necessary auxiliary switches.

- 3 Mixing and volume control dampers shall be of the modulating type.
 - (a) actuators shall be provided with spring returns where they are specified to open or close on power failure
 - (b) all fresh air dampers shall close on power failure of emergency and normal plant shut down
 - (c) all actuators shall be provided with position and direction indicators.
- 4 Mixing and throttling dampers shall be sized to provide adequate control over the full movement of the dampers, giving near linear characteristics without incurring high pressure drops which should not exceed 10 % of the controlled circuit pressure drop when fully open.
- 5 Rotation angle of the damper motor spindle shall where possible correspond with the required operating angle of the damper to which it is connected.

9.4.5 Step Controllers

- 1 Step controllers shall have adjustable differential and time delay between operations of each step and speed of loading and unloading. Each stage shall operate in sequence. The controllers shall be capable of interlocking with each other for series operation from the same sensor output.
- 2 The controllers shall recycle to ensure that on normal shut-down, power failure or manual interruption of the power supply, the controllers recycle to the "off" position before reenergising the controlled circuits.
- 3 All contacts shall be suitably rated for the imposed load or loads
- 4 Where used to control electric air heaters, step controllers shall be arranged to switch the heaters on in three phase balanced stages not exceeding 9.0 kW per three-phase stage except that stages up to 3 kW may be single phase, providing the supply air temperature does not vary by more than 4 °C. per stage. A time delay of not less than five seconds shall precede each stage after the first on loading heaters.
- 5 Switching condition shall be indicated by lamps on the front face of the controller.

9.4.6 Standard Control Interlocks

- 1 Unless otherwise specified the following equipment interlocks shall be provided:
 - (a) provide timers in the control circuits of all pumps to enable the pumps to continue to run for a period after such-down of cooling plant
 - (b) on plant start up and shut down operation, control circuits shall be arranged for staggered switching of motors to avoid simultaneous large electrical loads being imposed on the power cabling and power plants
 - (c) under normal operating conditions, the extract fan starters shall be interlocked with their respective supply fan starters and stop locks
 - (d) humidifiers and electric heater batteries shall be interlocked with their associated supply air fan to shut down the humidifier and electric heater battery when the supply fan stops, or on power failure
 - (e) fresh air inlet and discharge dampers shall close on normal plant shut down and power failure. Operation from smoke detectors shall be as specifically required by the local authority or as per the dictable of the fire alarm and control system
 - (f) on full fresh air plants the air inlet dampers shall open before the fan can operate, by use of damper motor end switches

- (g) where duty and stand-by pumps are provided, the selected duty pump shall start and operate as required. Should the duty pump fail to start, a fault alarm shall be given and the stand-by pump, after a pre-set period, shall operate. The same automatic change-over sequence shall apply should a pump fail during normal running
- (h) when electric heating batteries and cooling coils are to be operated in sequence a dead zone shall be provided between each sequence
- (i) all chilled water valves shall close on all plant shut down conditions unless otherwise stated.

9.4.7 Control System Conduits and Wiring

- 1 Wherever possible conduits are to run in poured concrete from control points to equipment locations. Terminations at both ends are to be standard electrical junction boxes. All conduit work will be done in accordance with the relevant provisions of Section 21, Electrical Works, and shall be undertaken by the Electrical subcontractor. In the event that conduit work is not undertaken at the time of concrete pouring, then the specified conduit shall be used and run on the surface, except in areas where surface conduit would be unacceptable to the Consultant.
- 2 Wiring shall be done in accordance with the relevant provisions of Section 21, Electrical Works, with the minimum wire size of 0.8 mm² with an outer metal screen for extra low voltage systems and 1.5 mm² for line voltage systems. In any event all wire sizes shall be calculated to ensure proper voltage conservation up to actuator points.
- 3 Wiring shall be the responsibility of the specialist control supplier (SCS) but may be done by the Electrical subcontractor under the supervision of the SCS.

9.4.8 Start up and Commissioning

- 1 After completion of the control system installation, the control supplier shall regulate and adjust all thermostats, control valves, damper motors, etc., and place them in complete working order subject to the approval of the Consultant.
- 2 Complete instructions shall be given to the operating personnel. Such instructions shall be exclusive of the time required for regulating and adjusting.

9.4.9 Guarantee

- 1 The control system herein specified shall be free from defects and workmanship and material under normal use and service. If within 400 days from the date of practical completion certificate any equipment herein described is proved to be defective in workmanship or material, it shall be adjusted, repaired or replaced free of charge.
- 2 The SCS further guarantees that all components used on the project are State-of-the-Art components and that parts and service, etc., will be fully available for them for a period of at least 10 years after the date of acceptance. In the event of non-availability at any time in this period, the SCS is to replace the particular class of item with a similar functional item for which spares, service, etc., are available.

9.5 CHILLED WATER TREATMENTS

- 1 The chilled water system shall be prepared as detailed in Part 5, Chilled Water Pipework. The system will then be further treated.
- 2 Prior to testing and commissioning, the Engineer shall be provided with a water conditioning programme, to control water quality. Cleaning shall be supervised, and programme of conditioning administered by the conditioning company.

- 3 For pre-commission cleaning, the system shall be dosed with the prescribed amount of the non-acid cleaning agent and a surfactant as advised by the company supplying the chemicals
- 4 The cleaning agent shall be run into the system and retained for a period of 72 hours or more as advised by the company supplying the cleaning agent. At the end of this period the system shall be drained and flushed with clean water.
- 5 All strainers and trapping points shall be inspected, and any debris removed while the chemicals are being circulated.
- 6 System shall be refilled with clean water, re-circulated or run through for a further four hours, and again drained and flushed. The flushing shall continue till the effluent is clear, colourless, odourless, free from suspended solids and such that the iron level is not more than 10 ppm and the conductivity is no more than the make up water.
- 7 Upon completion of flushing all strainers shall be inspected and any debris removed.
- 8 The system shall be refilled with clean water and a specified amount of inhibitor added.
- 9 The Contractor shall arrange for an analysis of the system's water after the cleaning operation, and shall submit a report to the Engineer.

9.5.2 Start up Chemicals

- 1 The supply of all chemicals for system start up shall be the scope of this Contract. Chemicals sufficient for contractual maintenance period shall be arranged by the Contractor.

END OF PART