SPACE HEATING AND COOLING

Functional Requirements

Heating, where provided, should be from a heater battery located in the supply ductwork. Heat may be supplied either from a suitable electric supply or the main heating medium system. In Hazardous areas water / glycol heaters should be used and supplied directly or from a separate low pressure or low temperature system. It may be necessary for a number of heaters to be provided for separate compartments or for area zones where varying conditions are required.
Electric Air Heating Coils fall into three main categories:
(1) heavy cased flanged units to be used in exposed environments, also on all Ex'd' rated equipment where a robust casing is required to support the weight of the junction box;

(2) a medium cased flanged units to be used in internal environments; and;

(3) light cased flanged or spigot units to be connected to constant volume terminal units.

Sea water heating may be used if it has been determined that there is no requirement to heat a module above 0°C provided consideration has been given to material selection and problems of failing.
The use of sea water as a direct cooling medium through duct or AHU mounted coils is not generally preferred owing to the small air/water temperature differential and resultant extensive cooling surface area which creates a large weight, space and cost penalty. In addition poor control characteristics prevent maintenance of water velocities within the acceptable limits required for erosion prevention. For these reasons direct expansion, (DX), evaporators used in conjunction with a packaged refrigeration systems and using suitable zero ozone depleting potential refrigerants are preferred.
Whichever form of heating or cooling is chosen the equipment should be capable of satisfactory operation in temperature and humidity regimes likely to be encountered during service. For internal systems this would entail electrical protection to IP56, if deluge fire extinguishing systems are used.

Technical Guidance
Water / Glycol Type Heaters

Heaters should be constructed from copper tube and fins and the whole electro-tin plated after manufacture. Casing should be made from corrosion resistant materials. Headers and return bends should be enclosed as part of the case, but should be located out of the airstream.
Coils should be designed to be easily removable from ducts or equipment and arranged in sections as necessary. Intermediate support plates should be provided where necessary to add rigidity to the coil. Coils should be provided with drainage and venting facilities

Electric Type Heaters

Coils should be capable of both continuous and intermittent operation and the design should be such as to minimise air flow turbulence and air side static pressure loss.
The terminal boxes should be located on the top of the units. Where this is not possible side mounting can be used, but under no circumstances should be located on the bottom face of the coil casing where it is more vulnerable to water ingress. The elements should also be mounted so they can be withdrawn whilst leaving the casing in situ.
Generally, heaters should be arranged on stages, each stage giving an even exposure to the total cross sectional area of the air stream. A local isolating switch should be provided at the duct position, with lock-off facility for use when isolated for maintenance or withdrawal of the element is necessary.
Casings should be constructed from corrosions resistant materials and flanged according to the flange specification.
Elements should consist of sheathed black heat coils, typically comprising 80/20 nickel chrome resistance wire centred in Incoloy 800 sheaths by compressed magnesium oxide. They should be mounted on removable plates for easy withdrawal and maintenance and attached to a terminal box suitable for direct connection of external wiring.
Elements should have a maximum temperature rating in line with the chosen certification requirements such as T3, as established by BASEEFA. In addition, the watt output per unit area of element surface should be restricted to a level where the surface temperature of the element cannot exceed 150°C under normal operating air flow conditions.
It is usually preferable for the elements to be of the hair pin design in order to restrict the duty of any one element to a realistic value. To provide a degree of redundancy in the design, additional elements having a capacity of not less than 10% of the design load or two elements, whichever is the greater, should be supplied fitted as part of the coil design,
Extended contact surfaces in the form of fins-should not be used on the coils.
Elements should be sized so that the length of element outside the process air system does not heat up above 40°C in still air conditions, when subjected to an electrical load; either through conduction or its resistive load.
When heating elements pass through the casing they should be clamped by a compression fitting, with the air tight integrity of the fitting being achieved by suitable gaskets.
Face velocities should not normally be less than 2.5m/s or greater than 5.0m/s except when connecting directly to other items of plant, say in an air handling unit. However, under no circumstances should the maximum coil surface temperature be exceeded.
Single phase power supplies should normally be restricted to 3kW, with three phase supplies being used above this value, or as stated by the data sheet. Where three phase supplies are used the number of elements should be split to ensure the out of balance load across each phase is not greater than 2% or as dictated on the data sheet.
Separate terminal boxes should be used for the power supply and the safety control circuits. When designing large duty coil, or when the coil design is significantly influenced by the number of element blocks dictated by a step controller, then multiple terminal boxes may be required. Where multiple terminal boxes are used, guide vanes may have to be fitted to direct the air over the elements to ensure an even air distribution.

Where step controls are used the internal connection within the terminal box should be such that the single or three phase connections for each step are grouped together to minimise the required run length of the incoming power cable. The elements should also be arranged so as to minimise air temperature variations across the face of the coil.
The connection system employed to link the element terminal pins should be designed so that in the event of an one failing and there being a requirement to link up a spare unit, the change can be made without disconnecting the terminal box from the heater system or any changes to the incoming power cables.
These electrical connections should be supplied, protected, with the coil, for storage in the equipment stores offshore.
Terminal boxes should be of an adequate size and shape to minimise the possibility of short circuiting should a terminal connection become detached.
Terminal pins and element links must be numbered in accordance with a wiring diagram provided by the supplier.
All internal cross connections between the elements should be completed by the vendor. Three phase heater internal connections should be arranged that one 3-phase cable can terminate into one terminal box without the need for jump connections.
Incoming power cables within the terminal boxes should be fitted with heat resistant sleeves over all cores. Terminations of the incoming power cable should be screw clamp/pressure or plate type terminals for cables with cores up to and including 4 sq mm CSA. For cores greater than 4 sq mm CSA tinned copper crimped compression lugs should be used for each core. Connections in the terminal boxes should be suitable designed to cater for these connections.
Ex'd' connection boxes should be drilled or the required gland connections suitably sized for the cables to be used. Not less than two spare sealed gland connections should be supplied on each terminal box. Any spare or unused cable entry holes should be sealed.
Ex'e' and Non-Hazardous area connection boxes should be supplied with a removable pre-drilled gland plates, adequately sized and located to ensure ease of installation, of rated cable glands and all cable cores terminated.
All heaters should be fitted with both 'high air temperature' and 'high element surface temperature' thermal cut-outs, each with automatic reset. Flameproof types should be fitted n Hazardous areas. Either thermocouples or resistance temperature devices should be used to protect the elements from over heating.
Each heater bank should be protected, by one over-temperature device. This detector should be clamped to the element at a point where it is anticipated that the highest element temperature will occur. On three phase heating coils each bank of elements connected to a phase will be fitted with an over temperature device. On step controlled heating coils the over temperature device must be connected to the lead bank of elements.
Where design restrictions necessitate the use of more than one terminal box on a heating coil, each bank of elements should be protected as though they were a single coil. Additionally, a high air temperature sensor should be fitted on the down stream side of the elements, this should be set to trip at around 175°C.
Heaters should be designed with no moisture traps with all parts easily accessible for cleaning and inspection. Under exceptional circumstances drain traps may have to be included, these should be of an adequate depth to retain a seal against the full static head pressure of the fan and of such a diameter as to prevent clogging from salt solidification.

Unit Heaters

Unit heaters should be of the heavy duty industrial type, and should use electricity (black heat only) or water/glycol as the heating medium.
Fans may be of the direct driven axial or propeller type. An inlet wire protection guard should be fitted. Units should recirculate air only and should not introduce outside air.
Motors and electrics, including controls and safety devices, must be suitable for the area classification for their location.
The heater outlet should be fitted with horizontal adjustable louvre blades to provide approximately 160° deflection from near vertically upward to near vertically downward. These blades should be of robust construction, and provided with locking device. The blades should not be interlinked.

Sea Water Cooling Coils

Sea water cooling coils should be constructed from titanium header and tubes. Casings should be made from corrosion resistant materials. Headers and return bends should be enclosed as part of the case, but should be located out of the air stream.
Coils should be designed to be easily removable from ducts or equipment and arranged in sections as necessary. Intermediate support plates should be provided where necessary to add rigidity to the coil.
Coils should be provided with easily accessible drainage and venting facilities.

DX Evaporator Type

This type of machine traditionally used R22 as a refrigerant. Production of R22 is being phased out by 2015 and any new equipment should therefore be specified with a less environmentally harmful refrigerant, such as R407C, R410A or G2032.
The refrigeration system should be designed to maintain the required internal environmental conditions within specified limits when it has been proven that free cooling from the fresh air supply system is unable to meet these needs. It should operate as part of an HVAC system in conjunction with an air handling unit and should be governed by the HVAC control system.
The refrigeration system should be suitable for continuous full load operations and complete with integral automatic capacity to maintain the desired unit capacity at all times from no-load to 100% duty. Hot gas bypass should only be used if it is not possible to achieve 100% turn down with the compressor unloading function.
The refrigeration package should be capable of both continuous and intermittent duty with long idle periods. For both applications facilities should be provided to ensure the maintenance demands are kept to a minimum.
Every effort should be made to ensure the equipment purchased is the manufactures standard product. This will greatly reduce the purchase cost, HVAC design and system interface costs over a customised unit. To minimise the cost the equipment should be located in a Non-Hazardous area, fed from a non secured electrical supply, ensuring isolation in the event that a hazard is detected. This will permit the use of non Ex(d) rated equipment permitting a far wider range of compressor types and electrical components to be selected.

The controls used should be standard refrigeration, industrial quality components.
Coils must be constructed from seamless de oxidised copper tubes and fins, the whole assembly must be electro-tin plated after manufacture. Refrigerant distributors should also be constructed from seamless de oxidized copper tube, designed to ensure an equal flow of refrigerant to each tube. Casings should be made from 316 Stainless Steel and flanged to allow coil removal with minimum pipework disturbance. Return (section) connections should be fitted with a copper header designed to ensure complete drainage of any oil in the coil. Headers should be mounted within the casing with only one penetration of the casing per refrigerant circuit.
Where required to operate with duplicate compressors, coils should be arranged for independent refrigerant circuits by face interlaced circuits within a single coil.
Each coil casing should incorporate; a welded full coil depth insulated Type 316 Stainless Steel drain tray, complete with a minimum 20mm drain tapping and manometric trap. Where coils are mounted in AHUs the drain tray should be incorporated in the unit and not be a part of the coil frame.
Coils should be selected to avoid moisture carry-over into the airstream without the use of eliminator plates, and the face velocity should not exceed 2.3m/s. Where this is not practical a moisture eliminator section should be installed downstream of the coil. The eliminator sections should be complete with a drain tray with minimum 20mm drain tapping and trap, and fabricated from 316 Stainless Steel.
Air should be prevented from by-passing the coil. All coil case connections or penetrations should be fully sealed.
Coils should be provided with drainage and venting facilities.
Open, semi hermetic compressors may be used providing the electrical equipment complies with the classification of the area in which it is located. Reciprocating, scroll and screw compressors are equally acceptable. The duty range for each of these compressor types would typically be:

Reciprocating

By the use of multiple units and cylinder unloading the full range of duties likely to be encountered offshore can be met by this machine type.

Scroll

With the present stage of development, these units can be selected within the capacity design range 10kW to approximately 160kW.

Screw

This machine is normally selected for large refrigeration capacities in excess of 160kW.
Under normal circumstances preference is shown for the use of sea water cooled condensing units as they can form an integral part of the compressor skid and need not be subjected to any special Hazardous Zone electrical requirements. Cooling water for these units normally would come from the service sea water supply, in the event that there is a need to run the refrigeration during a Hazardous shutdown, say in a control room or muster area, then it may be desirable to take the water feed from the deluge secure supply.

Air cooled condensers can be supplied for any duty likely to be required, but for duties above 160kW the units tend to become unacceptably large and consequently their use for larger duties is discouraged. These units should be rated as a minimum for Zone 2 area.
Where possible noise levels should be limited to 80dBA at 1 metre away from the unit in areas where personnel are in continual exposure, or as stated on the data sheet, whichever is the most onerous.
Resilient mountings should be selected to provide not less than 95% isolation of all frequencies transmitted to the supporting structure.
Where Air Cooled Condensers are used, fan outlets and possibly inlets should be fitted with flexible connections to provide not less than 99% isolation in all frequency bands from the connected components or duct spools.

Inspection and Testing

Each complete coil should be inspection and tested to verify its design performance. The tests should include, but not be limited to:
- kW loading by ohm meter;
- insulation resistance (no less than 2 Megohm)
- flash test (2 x line voltage + 1000V for 1 minute to check insulation resistance)
- function test to determine satisfactory operation of high temperature devices; and,
- static pressure drop.

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