NUCLEAR POWER CORPORATION OF INDIA LTD.
(A GOVERNMENT OF INDIA ENTERPRISE)
KAKRAPAR ATOMIC POWER STATION

TECHNICAL SPECIFICATION
FOR NEW NON-CFC
CHILLER
NUCLEAR POWER CORPORATION OF INDIA LTD.  
(A GOVERNMENT OF INDIA ENTERPRISE)  
KAKRAPAR ATOMIC POWER STATION

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A) LIST OF ADDITIONAL CHILLER SPARES
B) SPECIFIC REQUIREMENT OFF CHILLER MOTOR
C) TECHNICAL DATA SPECIFICATION SHEET
Sub: Supply, erection, testing & commissioning of 550 tons of refrigeration capacity chilling unit for KAPS

Scope:

Supply, Supervision for testing & commissioning and guarantee of 550 tons of refrigeration capacity factory run tested water cooled packaged chiller having centrifugal compressor with lubrication and control system, factory made starter, Evaporator, condenser refrigerant control device working on Environment friendly refrigerant HFC R-134a. It should include all the other components and jobs necessary for complete and operable chiller package.

Note: The chilling plant needs to be erected on the existing foundation as one to one replacement for the existing Kirloskar-McQuay make PEH-100 chiller.
1.0  **GENERAL**

This specification is intended to cover the design, manufacture, Assembly, Testing, Delivery, proper packing for transport to site of one No. of centrifugal type water chiller complete with all controls and accessories as specified herein for atomic power station. The scope of supply includes the following:

1.1 One no. centrifugal type water chiller working on HFC 134-a refrigerant.

1.2 Each shall be complete with the following:

   a. Centrifugal compressor along with driving Motor, Gear box etc.
   b. Lubricating arrangement for the above along with lubrication oil pump.
   c. Shell & Tube type water cooled condenser with companion flanges at inlet & outlet.
   d. Shell & Tube type water Evaporator with companion flanges at inlet & outlet.
   e. Insulation for the Evaporator & connection pipelines.
   f. Safety controls for condenser & Evaporator as specified in Cl. No. 5.7
   g. Automatic operation control as specified in cl. No. 5.7.2.
   h. Purge unit for evacuation of non-condensable gases if required.
   i. Lubrication oil recovery system for continuous bleeding of oil from the chiller.
   j. Local panel for the water chilling units as specified along with inter connecting wiring, tubing from various equipment to the local panel.
   k. Various measuring & indicating instruments as specified in Cl.No.5.7 and 5.8.2
   l. Suitable arrangement for lifting and handling of water chilling Units.
   m. All inter-connecting piping, fitting, valves etc. inside the plant as required.
   n. A common control panel which will be put along with existing control panel called common panel with interconnecting wiring from local to common control panel.

1.3 First charge of refrigerant and oil required for the water chilling units inclusive of losses during testing & commissioning.

1.4 Vibration isolating pads for the water chiller Units.

1.5 Spares & tools as specified.

1.6 Supervision during Testing and commissioning of water chilling Unit.

1.7 Any other equipment necessary for satisfactory operation of the water chilling units.

2.0  **STANDARDS AND CODES**

Unless otherwise specified, it is intended that tenderer will offer standard equipment for this specification, material of construction, construction of components, performance, testing of equipments etc., shall be in accordance with the latest edition of the appropriate standards of any one of the following:
2.1 ARI standard 550-74 : Standard for centrifugal water chiller.
2.2 ARI standard 450-61 : standard for water cooled condensers.
2.3 ASHRAE standard 22-61 : Methods of testing for rating of water cooler refrigerant condensers,
2.4 ASME code for Unfired pressured vessels, section VIII, Div 1.
2.5 TEMA Standards for class ‘C’ heat Exchangers.
2.6 Indian standard IS-660-1963 Safety code for mechanical refrigeration.
2.7 ISI-325 specification for 3 phase induction Motor.
2.8 PP-E-774 & 786 General specifications for squirrel cage induction motors.
2.9 All the specification as & when referred herein.

3.0 GENERATION DESCRIPTION

The Atomic Power Station consists of two identical Power generating plants each having the rated capacity of 235 MWe. The chilled water units are required to supply chilled water to the process cooling equipments and for Air Conditioning of various areas. Satisfactory operation of the power station will depend upon the reliable and uninterrupted supply of chilled water and hence the chillers are required to be of rugged and well-proven design.

The details of the system will follow the enclosed data sheet for chillers.

4.0 OPERATING CONDITIONS

4.1 Site Conditions and Location of plant

The conditions prevailing at site and location of the plant is given in the general specification.

4.2 Chiller Water

Demineralised water with chemical inhibitor shall be available. The quality of water shall be as mentioned below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid handled</td>
<td>Demineralised water with corrosion inhibitor</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>6.1°C – 10.1°C</td>
</tr>
<tr>
<td>PH Value</td>
<td>8.5 To 9.5</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>5 ppm</td>
</tr>
<tr>
<td>Silica</td>
<td>0.1 PPM (Max)</td>
</tr>
</tbody>
</table>

LiOH is added in DM water to maintain pH between 8.5 to 9.5 and Hydrazene is added to control dissolved Oxygen.
4.3 **Cooling Water**

The cooling water for the chiller condenser will be made available. The quantity of water will be 649 m³/hr per chiller. The water inlet temperature will be 38°C. The quality of water shall be as follows:

I) liquid handled Water
II) HP Value 8.5 to 9.0
III) Total dissolved solids 250 PPM
IV) Total suspended solids 100 (max.) PPM
V) Chloride as CaCO₃ 100 (max.) PPM
VI) Calcium as CaCO₃ 100 (max.) PPM
VII) Total Hardness as CaCO₃ 200 (max.) PPM
VIII) M.O Alkalinity 200 PPM as CaCO₃

4.4 **Power Supply**

The following supplies shall be made available at chiller location by site.

1. 6.6 KV, Three phase, 50 Hz --- Through circuit breaker – Motor live terminal shall not be exposed with gas in Compressor Chamber, any shorting requirement exists it shall be done in Compressor Chamber and cable terminal block shall be separate without any gas sealing. Cable size 150 mm² Aluminium. Motor terminal block shall be as per HT terminal block specification, Silica gel breather, Phase separator, space heater provision, Flexible cable link, Thermal insulation, 11 kV insulator for Cable support. Cable Entry holes for 3 X 150 sq mm Al power cable / CT cable / Space heater cable. For terminal Box it has to be ensured that adequate volume of Terminal Box to contain the pressure built up under fault condition.

2. 415 V, Three Phase, 50Hz --- Through MCC – cable size 16 mm² Aluminium.

3. 48 v DC control supply for CB closing and tripping logic circuit – through MCB – cable size 0.7 mm² Cu.

Chiller –compressor motor is to be powered from 6.6 KV.

Control supply for microprocessor based circuit, lubrication oil pumps & heaters, gear heaters etc and any other such requirement shall be drawn from three phase 415V supply. Necessary step down transformers as per the circuit shall be provided by the supplier.

The interfacing relays between microprocessors and CB closing and tripping circuits shall be of 48V DC rating since the control supply of CB is of 48 V DC.

6.6 KV, 150 mm² cable, along with termination kit shall be provided by the site up to motor TB. Glanding and cable termination shall be in the scope of NPCIL.
48 V DC Control circuit cable, 415 V AC Power cable will be brought up to local control panel by the site. Glanding and cable termination shall be in the scope of NPCIL.

If any CT requirement for Chiller control then its supply and installation shall be in the scope of supplier.

If the equipment is designed for voltage other than the specified voltage, necessary equipment for rectification shall be included in the scope of supply.

All Microprocessor based circuits and components shall housed in a separate panel mounted on the chiller.

Auxiliary power & Control supply panel which shall also be installed on chiller unit and shall house the following:

a) Indications such as CB Close, CB Open, CB Trouble, chiller process Trip / Chiller not ready to start etc.

b) CB Close / Open / Normal HS with spring return to Normal position type. Ammeter – Supply to this ammeter shall be given from 75/1 CT via Transducer by the site. Cable for this ammeter will be laid upto Local Control Panel by the department. Glanding and cable termination shall be in the scope of NPCIL.

c) Terminals of 75/1 CT Control Cable from CB shall be drawn upto local control panel by the department. This can be used as current feedback in the microprocessor circuit or otherwise as per requirement.

All the cables require between Microprocessor base Local Control panel and Auxiliary Power & Control Supply Panel, both unit mounted, shall be supplied, laid, terminated and commissioned by the supplier.

No separate 6.6 KV CB / Contactor need to be supplied by the supplier. The existing CB at site along with protective relays will be used for this purpose.

4.5 Grounding

Chiller – Compressor motor TB, entire Chiller Unit, Local Control panel must be grounded by insulated / un-insulated copper stranded conductor of require cross section as per IS at two separate earth pads. The maximum distance between earth pad to point of the equipment shall be not more than 20 meters. Grounding conductor shall be supplied laid and terminated by the department. The supplier shall provide suitable earthing points on the chiller unit.

4.6 Performance

It is required that the chilled water shall be delivered at a temperature of 6.1°C.
The inlet Temperature of chilled water to the chiller Units shall be 10.1°C.

The total quantity of chilled water required for each Unit is 418 m³/hr. To meet this requirement, three nos. of chilled water pumps (Two working + one standby) each of 450 m³/hr capacity have been provided.

The total quantity of cooling water required for each chiller condenser Unit is 649 m³. This requirement is met by three nos. of cooling water pumps (Two working + One standby) each of 675 m³/hr capacity.

Considering the above conditions bidder quote for One No. of chiller of 550 TR of capacity.

5.0 EQUIPMENT DESCRIPTION

5.1 GENERAL DESIGN REQUIREMENT

The equipment supplied shall be suitably constructed for safe and proper operation under all conditions described or implied in this specification without undue strain, Vibrations, Corrosion or other operation difficulties. All parts which are subjected to substantial temperature changes shall be designed and supported so as to permit free expansion or contraction without resulting in leakage, distortion and excessive strains in the equipment part and the parts subjected to wear, corrosion or other deterioration requiring adjustment, replacement and repair, All such parts shall be of suitable material or suitably lined for keeping maintenance to minimum. All close fitting parts that are changeable shall be machined to gauge.

The equipment supplied shall be designed for seismic duty. The vendor shall submit the sample calculations explaining the method being adopted for this purpose.

5.2 Water chiller

The equipment offered shall be standard product of the manufacturer, which has been thoroughly proven for satisfactory service and reliability.

5.3 Compressor

The compressor shall be hermetically sealed centrifugal type (single stage), forced lubricated, oil cooled type. The compressor casing and volute shall be Gray cast iron casting conforming to IS- 210 Gr. 25 or equivalent. The impeller shall be cast aluminum alloy the specification of which shall be as per ASTM – B 26-65 SG 70A, alloy or equivalent proven standard product of the manufacture.

The impeller shaft shall be forged steel conforming to IS : 1875 Gr.3 equivalent. The impeller and shaft shall be dynamically and statically balanced. The compressor shall be
fitted with a vane control device at suction side to regulate the quantity of flow of refrigerant automatically depending upon the load demand.

The compressor shall be driven by the motor of adequate capacity, through a set of gearing for the refrigeration capacity selected with adequate margin in power, than which is required for driving the compressor under maximum load condition.

The gear drive of the compressor shall be encased in the casing. The teeth of gear and pinion shall be hardened. The lubrication system shall consist of motor driven oil pump, filter, oil cooler, heater oil pressure regulator, necessary gauges & control valves to permit the system to operate automatically. Control shall ensure compressor lubrication before starting the machine and until shaft stops rotating during shutdown. A provision for lubrication during abrupt stopping of compressor due to power failure shall also be made.

5.4 Heat Exchangers (Condenser and evaporator)

Heat Exchangers shall be of shell & Tube type with water in the tube side and refrigerant in the shell side. The design, fabrication and testing of all the Heat Exchangers shall conform to the TEMA- standards for class C heat exchangers and ASME code for unfired pressure vessels section VIII. Div. I. the selected design pressure shall have a 10% margin over the maximum working pressure. The maximum working pressure in the tube side will be 10.5 Kg/cm² g.

The specification of condenser & evaporator shall be as follows:

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Description</th>
<th>Evaporator</th>
<th>Condenser</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Test pressure of tube</td>
<td>17.5 Kg/cm²</td>
<td>17.5 Kg/cm²</td>
</tr>
<tr>
<td>2.</td>
<td>Max. Pressure drop on water side</td>
<td>6.4 MWC</td>
<td>8.9 MWC</td>
</tr>
<tr>
<td>3.</td>
<td>Fouling factor</td>
<td>0.0001 hr.m².ºC/Kcal</td>
<td>0.000205 hr. m².ºC/Kcal</td>
</tr>
<tr>
<td>4.</td>
<td>Chiller/ Cooling water flow rate.</td>
<td>418 m³/hr</td>
<td>649 m³/hr</td>
</tr>
<tr>
<td>5.</td>
<td>Material of shell</td>
<td>IS 2002 / SA 516 Gr. 70</td>
<td>IS 2002 / SA 516 Gr. 70</td>
</tr>
<tr>
<td>6.</td>
<td>Material of tube</td>
<td>Copper</td>
<td>Copper</td>
</tr>
<tr>
<td>7.</td>
<td>Inlet / outlet Temp. of water</td>
<td>10.1 / 6.1</td>
<td>35.0 / 38.4</td>
</tr>
</tbody>
</table>

Based on the above factors design calculations to be done and copies of the design calculations shall be submitted along with the offer. Necessary drain and vents shall be provided.

Water boxes and covers shall be provided so that each tube sheet can be exposed without disturbing the piping connection. Endless gasket shall be provided between the flanged joints.
The shell side test pressure shall be calculated based on the refrigeration cycle and the refrigerant pressure required as per the design as per the refrigeration capacity of 550 TR. The size of the exchangers, shell thickness, diameter & thickness of the tube shall be calculated and specified. The operating shell pressure, design pressure and test pressure of condenser and evaporator shall shell shall be specified.

Tubes support of adequate strength shall be provided to prevent the tubes from sagging and vibrating. The supports shall be as per TEMA standard.

The tubes exchanger shell, water box, and cover and tube sheet shall be of carbon steel conforming to IS 2002 Gr. 2A / SA 516 Gr. 70 or suitable equivalent.

The tubes shall be of copper, conforming to ASTM- B 111 specification or equivalent, preferable with fins made integral with the tube. The tubes shall be suitably expanded in tube sheets provided at both the ends to avoid leakage of refrigerant or water. The tube inlets shall be flared to avoid disturbance in water flow. Number of fins required per cm., number of tubes required & number of passes shall be calculated & arrived at based on the Heat transport calculations.

5.5 Anchor bolts, nuts etc.

Anchor bolts, Nuts Bolts and seating steel work if required shall be supplied with the equipment. Only hexagonal nuts shall be used for holding down the equipment. All bolts holes shall be spot faced for nuts. In special cases where necessary, spot facing may be omitted.

5.6 Foundation details.

Indented chiller unit will be erected in place of one of the chiller unit working on R-134a. Hence the chiller needs to be installed on the existing foundation. So the design of the chiller is to be such that it can be accommodated on the existing foundation.

The new chiller Unit will be erected in place of existing chiller, hence the existing chilled water, process cooling Water and Electrical supply connections will be used for the new chiller. The Orientation & location of the chilled water & process water inlet/outlet connections and location of the Motor terminal box for new chiller shall be such that minimum modifications are required to be carried out at site during its Erection. The feasibility for modification & above changes shall be studied before finalization final quotation.
5.7 Controls

5.7.1 Safety Controls shall be provided for the water chilling units to trip the Compressor if any one of the following faulty condition occurs.

1. Condenser High Pressure
2. Evaporator Low Pressure
3. Condenser water low flow
4. Chiller water low flow – upto 60% of full flow
5. Low chilled water temperature
6. Lubrication oil pressure low
7. Bearing Oil temperature High – for both motor & compressor
8. Compressor Motor overload (feedback from starter)
9. Compressor Motor winding temperature High.
10. Control supply Failure
11. Starter Fault (feedback from starter)

Contractor shall supply necessary instruments required for sensing the above conditions and tripping the compressor motor in case if the fault occurs. The control schematic shall be such that the compressor motor is locked out under any faulty conditions which can be reset manually after clearance of the fault. All the sensing instruments shall be mounted locally whereas the relays / contactors shall be mounted in the local panel (location of Common Control Panel is proposed 25 meters approximately from the location of on the chiller Units where all alarms indications & Controls to be arranged for the operator aid) necessary wirings / tubing and fittings from various instruments / tapping points to the local panel shall be provided by the supplier. Contacts of the contactors corresponding to individual faulty condition shall be brought out in a suitable terminal block provided on the local panel for interconnecting with the remote panel to provide required indication / annunciation on the common control panel. Common control panel shall be located near to the chilled water plants and will provide annunciation of various parameters related to chiller compressor & Motor. All wiring between local control panel & common control panel will have to be carried out by the supplier.

Relays and contacts wired in microprocessor circuitry shall be voltage grade suitable to the application. Required modification in logics and control circuitry based on experience of earlier commissioned chiller shall be incorporated in this chiller unit also as directed by site at the time of supply.

5.7.2 The water chilling units shall be provided with capacity control arrangement ranging from minimum 10% to 100% rated capacity to regulate chilled water outlet temperature. Proportional plus integral type thermostatic control shall be provided to regulate the position of the vanes at the compressor inlet depending upon the load demand.

All the instrumentations shall be provided with rigid supporting arrangement so as to ensure that no spurious operation of the instrument takes place because of background vibration & noise.
5.8 Instrumentation

5.8.1 General

PLC/smart control base control system is required. It should have sufficient internal memory to log the all analogue and digital data with real time. Also log all alarm messages. Control system should be capable to store at minimum seven days data and it should have facility to view current data or history at same display unit/LCD. It should also have USB port to retrieval of data control unit to store in sectional PC.
Supplier shall furnish all the instruments indicated below. Any other instrument felt necessary by supplier for proper control & operation of the plant shall be included in the scope of supply. The specifications sheet and supplier drawings along with the inspection procedure for all the instruments and panels shall be subjected to purchaser’s approval. Each instrument shall be tagged with the number obtained from the purchaser.

Following things related to instrumentation need to be included in the documents to be supplied along with chiller.

1. Generally it is observed a common manual or drawing is prepared by supplier to cover more than one model of machine or it will be explaining about extended features of machine but those are not applicable to supplied machine. So it becomes important that supplier should clearly mention applicable and non applicable part in manual and drawing, to avoid confusion and mistakes. All new and special words & symbols used in manual must be explained in glossary.

2. ED must be prepared for particular commissioned machine on A-1 size sheet and every symbol of drawing should be clearly explained. This ED must get approved by KAPS dept. as per normal procedures.

3. Instrument GA and bill of material should be submitted and get approved by KAPS department.

4. The manual should include all Trouble shooting and fault diagnosis procedure.

5. The manual should include all instrument schematic with all logics details.

6. Chiller controller configuration procedure along with all passwords to change set points and other configuration need to be mentioned.

7. Supplier has to submit circuit diagram of electronic cards along with component layout and component specification.

8. Maintenance procedure should be given by supplier and instruments replacement procedure should clearly indicate about process isolation and power supply isolation.
9. Regarding field instrument following details must be submitted.
   * List of all instrument used on machine with tag description and function.
   * Principle of operation of every sensor.
   * Internal construction and circuitry of sensor.
   * Calibration check and calibration procedure for every transducer.
   * Sensor Healthiness check method and data e.g. D.C resistance, inductance, capacitance, calibration chart, and loading capability etc.
   * In case of PS and DPS set point value, range, hysteresis and adjustment procedure must be given.
   * Field instrument tagging should be done in field with description and unique identification no is to be given in consolation with KAPS technical Unit.
   * Supplier must submit all specification of instruments e.g manufacture name & address, model no. and all other technical parameter and details so it can be procured from open market.
   * List of recommended spares and spares supplied along with machine reed to be mentioned.
   * Field instrument cable should be routed properly with suitable conduiting for physical protection purpose.
   * Terminal wires must have ferrules on both ends for identification purpose.

10. Surveillance check list to verify healthiness of process and machines is to be mentioned. It should also indicate predictive maintenance required based on these data.

11. Healthy operating condition value and range of all process parameters should be mentioned in the manual in the form of chart and interpretation of deviation in values to be indicated.

12. Tuning procedure to tune system from process point of view and control point of view need to be mentioned in the manual.

13. Recommended PM activities for instruments and its procedure along with periodicity should be mentioned in the manual.

14. Electronic card extended and card checking procedure with test point on electronic card to be mentioned in the manual.

15. Grouping of same type of sensor based on its same specification & interchangeability to be done. This will provided guide lines for spare inventory to be maintained.

16. All indications provided on machine should have clear description.

17. Supplier should give licensed copy of complete installation software in PC along with software key.

18. All hardware for communication between PC and machine with networking topology details must be submitted by supplier.
19. During commissioning all sensors must be recalibrate along with KAPS person with complete written procedure.

20. Budgetary quotation of all recommended spares must be submitted along with tender document.

21. It is very important that submitted document must be adequate and in compiled manner, and it must get approved by KAPS department as per normal procedures.

22. All documents must be submitted in minimum five no. of copy.

23. Complete detail of instrumentation, controller, panels etc must be clearly described in your quotation itself and any deviation in supply from quoted item must be done with prior approval.

24. Language and description of your quotation must be very clear in meaning otherwise interpretation of any unclear description or language will be always done in favor of NPCIL.

25. PLC/smart control base control system is required. It should have sufficient internal memory to log the all analogue and digital data with real time. Also log all alarm messages. Control system should be capable to store at minimum seven days data and it should have facility to view current data or history at same display unit/LCD. It should also have USB port to retrieve data control unit to store in sectional PC. This is required for assessment of health of machine for long run and it is easy of fault diagnosis to take corrective action if it is happen.

5.8.2 Local control panel (LCP)

The water chilling units shall be provided with local control panel to perform operations such as starting / stopping of the compressor, automatic switching on / off of oil heater etc. The Local Control Panel shall be with modern instrumentation Technology with Microprocessor based control system. The panel shall provide all information regarding various operating parameters, set points alarms and trips. The LCP shall display vane opening indicator, pressure for compressor suction, discharge and lubrication oil pressure. All operating HS, PB on the panel shall be located at an elevation of 1.5 meters from the operating floor. Necessary RED & GREEN indication for equipment / Motor and lub oil heater shall be provided.

Detailed fabrication drawing, general arrangement of panel, bill of material, name plate description, elementary drawing, panel TL drawing shall be approved by the purchaser before start of manufacturing.
Evaporator / condenser flow etc. parameters which are required for annunciation / control from common control panel (Contractor’s scope) should be brought to TB or separate terminal strip. Also for all controls required for chiller like HS, PB indicating lamps, duplicate contacts shall be wired into terminal strip for further wiring to the common control panel. In addition to this 20% terminals shall left as spare.

Common Control Panel

The Common Control Panel shall be located in the Local chiller Control Room and shall be provided with the following devices/ indicator and controls.

I) Annunciator to annunciate on various process parameters related to chiller compressor, chiller pump and cooling water supply to chiller plant.

Some of these are listed below:

a) Condenser High pressure.
b) Evaporator low pressure.
c) Low Water flow in Condenser.
d) Low Lubrication Oil Pressure.
e) High Temperature Compressor Motor winding.
f) Compressor Motor Overload.
g) Control Supply Fail.
h) Starter Fault

B) ANALOGUE/ DIGITAL METER

a) Chilled Water Flow (4 – 20 mA feedback from flow meter by Dept.)
b) Process Cooling Water Flow for Condenser (4 – 20 mA feedback from flow meter by Dept.)

C) LED INDICATIONS

a) Chiller ‘ON’ & ‘OFF’ with Red & Green Colour LED respectively.
b) Oil Pump ‘ON’ & ‘OFF’ with Red & Green Colour LED respectively.
c) Heater ‘ON’ & ‘OFF’ with Red & Green Colour LED respectively.

D) EMERGENCY STOP

For Chiller Compressor Emergency Stop Should be provided locally on chiller itself and on common control panel indicating boldly ‘EMERGENCY STOP’.

E) Common Hooter for annunciation of any Chiller Abnormal Condition is to be provided along with necessary accessories, Relays and wiring.
F) The Annunciation & Hooter shall be provided with push buttons for Acknowledge, Reset & test.

**Auxiliary Power & Control Supply Panel**

The above panel shall be located on chiller unit and will Supply Power to Microprocessor based local Control Panel. This will house the following:

Auxiliary Power & Control Supply Panel which shall be installed on chiller unit shall house the following:

a) Indication such as CB Close, CB Open, CB Trouble, Chiller Process Trip/ Chiller not ready to start etc.

b) CB Close/ Open / Normal HS with spring return to Normal Position type.

c) Ammeter – Supply to this ammeter shall be in given from 75/1 CT via transducer by the site. Cable for this ammeter will be laid upto Local Control Panel by the department. Glanding and termination shall be in the scope of the supplier.

d) Terminals of 75/1 Ct Control Cable from CB shall be used as current feedback in the microprocessor circuit or otherwise as per requirement.

5.9 **GENERAL**

5.9.1 **CONSTRUCTION DETAILS**

The Control panel shall have the following features:

a) Unit mounted type.

b) Constructed of smooth sheet of not less than 2 mm thickness and stiffened suitably.

c) Construction shall be dust and vermin proof. Ventilation louvers with suitable filters shall be provided to avoid dust from entering the panel.

d) Space heater shall be provided.

e) The panel shall be applied with two coats of primer and shall be finished by aircraft gray colour, shade no. 693 of IS 5, in over baked process. Before applying this, the panel shall be pretreated for degreasing, derusting and phosphating (seven tank process). The panel internal colour shall be fully glossy white.

f) The panel shall have hinged door with locking devices.

g) Panel shall be provided gland plates with glands. Neoprene gaskets shall be provided for all doors and opening.

h) Panel shall be provided gland plates with glands. Neoprene gaskets shall be provided for all doors and opening.

5.9.2 **WIRING**

The panel shall be supplied shop wired, assembled and tested. The control switches and indicating lamps (LED type) are to be supplied by the supplier for remote indication / operation, necessary internal wiring shall be done by the contractor and brought out un panel terminal, so that these can be connected at site by others without any difficulty.
Each terminal shall be suitably numbered and shall be of industrial heavy duty type. At least 20% spare terminals shall be provided. The terminal box shall be disconnecting link type so that the external cable shall be isolated from the internal wiring while doing maintenance work on the panel. All the power and signal connection shall be segregated as per their voltage. All the internal wiring shall be PVC insulated, 1.5 mm² stranded copper conductor 650 V grade. The panel electrical control system shall be rated for 240 VAC single phase, 50 Hz electrical power supply. All connection to the instruments or switches, where screw parts are provided shall have crimped connector fixed on the wires. Whenever space permits, plastic race ways may be supplied, otherwise a neat assembly of wires cleated together with nylon/ PVC straps shall be provided. The maximum distance between the anchoring point shall not be than 100 mm. unused areas of panel shall be kept free of wiring to facilitate installation of future equipment. Wiring between points shall be point to point with no splicing or ‘T’ connections. The wires to any one equipment/ instrument shall be neatly cleated together.

5.9.3 GROUNDING

Each electrical instrument of device shall have one grounding terminals and shall be connected by insulated wires to the ground of the panel.

5.9.3 PANEL DRAWING FOR APPROVAL

Control wiring diagram, general arrangement drawing, terminal list and bill of material for the local panel, manufacturer’s leaflets/catalogues of all instruments shall be got approved before final fabrication.

5.9.5 IDENTIFICATION

Each instrument shall be identified by aluminum tag of suitable dimensions affixed to it firmly in a prominent position by a corrosion resistance wire and bearing the tag no. in an engraved from. The tag number for the instrument shall be obtained by supplier from purchaser. Name plate details shall be made of lamicoid. These PLY (black/ White / Black) name plate shall be of 10 mm height for panel and 3 mm for other.

5.10 DRIVE MOTORS HERMETICALLY SEALED

5.10.1 The motors drawing the compressors shall be designed to suit operating conditions as described in clause 4.40 of the specification and shall confirm to PP-E-774 and PP-E-786 attached herewith.

5.10.2 DESIGN PARTICULARS

The specific requirements sheers for 6.6 KV induction motor and 415 V induction motors have been enclosed as Annexure ‘A’ to motors specification No. PP-E-774 and PP-E-786 attached herewith.
5.10.3 DOWELS

Unless otherwise approved by the purchase motor shall be designed to permit convenient access for drilling vertically through motor feet or mounting flanges for installation of dowel pins after motors are mounted with driven equipment.

5.10.4 INSPECTION PLUGS

Inspection plugs shall be provided on the motor in each section and shielded for air gap measurement.

5.10.5 TERMINALS

Terminals shall be designed to make cables to the following specification:

**Power cables be for 6600 volts Motors**

6600 Volts grade XLPE cable, sheathed single wire armoured aluminium conductors cables, number of core to suit application.

**Control Cables**

250/440 Volts grade PVC insulated, PVC sheathed multi core cable furnished steel wire armoring. Minimum cross section for copper conductor shall be 1.5 sq. mm and for aluminium conductors shall be 4 sq. mm. for inter panel wiring 650/1100 V grade wire shall be used.

6.0 ERECTION AND MAINTENANCE TOOLS

The supplier shall furnish a complete unused set of all special tools, wrenches etc with necessary tool boxed as required for erection, maintenance, overhaul and complete replacement of any equipment being supplier under this specification.

The supplier should furnish the spare parts recommended by the manufacturer for trouble free operation of the plant for five (5) years, as optional with price quoted separately for each item. In addition to above, the supplier should quote the price for the addition spares listed in the annexure-A -1 attached.

7.0 INSPECTION AND TESTING AT MANUFACTURER’S WORKS

7.1 supplier shall submit QA plan for approval of NPCIL. Quality surveillance by the Purchaser will be carried out at the supplier’s works or at the premises of subcontractor of the supplier as per approved QA plan.
The supplier shall provide inspection to establish and maintain quality of workmanship in his and his sub-contractor’s works, to ensure the mechanical accuracy of components, compliance with drawings, identify and acceptability of all material part and equipment. He shall conduct all tests required to ensure that the equipment and material furnished shall conform to the requirement of applicable codes.

All tests and test procedures by the manufacture shall be submitted to the purchaser for the prior approval. Purchasers shall be notified well in advance of the fabrication and the major shop tests of the equipments for the purpose of making general inspections and for the progress report. The purchaser’s representative shall be given full access to the shop in which equipment is being manufactured or tested. All test records shall be made available to him. A final inspection will be made by the purchaser’s representative before the dispatch of the equipment. Final routine and performance tests for the complete unit shall be carried out in presence of the purchaser’s representative.

All material used for the manufacture of the equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the purchaser before the final shop inspection. In case the relevant correlating test certificates are not available, the supplier shall arrange to carry out necessary test required by relevant codes at his cost.

7.2 GRAY IRON CASTINGS

7.2.1 Gray iron casting material shall be in accordance with IS-210 Gr. 25. Test bars shall be cast for physical tests from the same ladle of metal as the castings they represent. A copy of the ladle analysis shall be submitted to the purchaser. Physical tests on test bar shall be carried out in the presence of the purchaser’s representative.

7.2.2 The casting shall be sound, clean and free from porosity, blowholes, hard spots, cold sheets distortion and other harmful.

Areas which in the opinion of the purchaser will create doubts about soundness of the casting shall be subjected to Dye Reentrant test and/or Magnetic particle test.

No repairs shall be carried out without prior indication to and approval of the purchaser. No welding of CI parts will be permitted.

7.3 FORGINGS

7.3.1 All forgings shall be subjected to magnetic particle testing, at the areas of fillet and change of sections. The testing is to be carried out after the rough machining operation (125-Micro inches). The test procedure shall be as per ASME boiler and pressure vessel code sec. VIII Division. Appendix VI).
7.3.2 Any defect that will not machine out during the final machining will be gauged out, fully inspected by dye penetrant and/or magnetic particles inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indications which prove to penetrate deeper than 21/2 % of the finished thickness of the forging shall be reported to the Purchaser giving location, length width and depth of such defect.

7.3.3 The prod method will be used with direct current for carrying out the magnetic particle test. The direction of field will be the most suitable one to obtain the clearest indication of any defect. The choice of wet and dry particles will be at the supplier’s discretion. All forgings shall be demagnetized after carrying out the test.

7.4 WELDING

7.4.1 All welding shall be performed in accordance with the ASME code for boiler and pressure vessels. Filler metal welding electrodes to E-60 series to AWS-ASTM Specification shall be used for welding. All welding electrodes shall be approved by the Purchaser. The electrodes shall be dried before use to avoid porosity.

7.4.2 The supplier shall have all welding procedure, welding equipments and operators qualified in accordance with ASME boiler and pressure vessel code. Sec IX (on welding qualifications) prior to commencing and welding on the works.

A list of qualified operators to be used on the work shall be made available to the purchaser for his approval.

Any procedure for the repair of the defects in the weldments and all other materials shall be submitted to the purchaser for his approval prior to any repair being done.

7.4.3 The root and final passes of all the welded joints shall be tested by liquid penetrant examination according to the method outlined in the ASME code for Boiler and Pressure vessels Section VIII Div. 1 Appendix VIII.

7.4.4 The Purchaser will call for radiograph of the work if any operator in his opinion is not maintaining the standard of Workmanship. Should this radiograph prove defective the work done by the operator since his last test shall be radiographed at supplier’s expense.

7.5 HYDROSTATIC TESTS

All parts subjected to water pressure shall be hydrostatically tested at net less than one and half times the design pressure for the minimum period of at least 30 minutes. No leakage or drop in pressure shall be allowed.

7.6 AIR TEST / VACUUM TEST
All parts subjected to gas pressure shall be air attested to 1.5 times the design pressure. No leakage shall be allowed, these parts shall also be vacuum tested to a pressure of 5 mm Hg absolute. The vacuum shall be maintained in refrigeration unit for a period of 24 hours without losing more than 5 mm of Hg.
7.7 PERFORMANCE TEST AT SUPPLIER'S WORKS

The water chilling units shall be tested as per ARI code 550-74 preferably at supplier’s works in the presence of purchaser’s representative for a period of not less than 4 hours at design condition to demonstrate the satisfactory performance of the machine. This shall include the following.

a) Determination of cooling capacity at full load and part load (minimum four different loads) at design chilled water outlet temperature and design condenser water inlet temperature.

b) Demonstration of operation of various safety controls.

c) Measurement of power consumption (KW input to motor) at each load.

All the necessary instruments (duly calibrated), equipments, heat loads etc. required for carrying out the performance test as indicated above shall be provided by the supplier. Results of the performance test shall be submitted to the Purchaser for approval.

7.8 All the instruments shall be calibrated and certificate shall be furnished.

7.9 The control panels shall be subjected to test to show that the panels have been satisfactorily designed and manufactured in accordance to the relevant IS Standards. Following tests shall be carried out on the control panel prior to mounting of electronic devices.

a) Continuity checks for wiring errors.
b) Functional test by simulating working conditions.
c) Insulation resistance test.
d) High Voltage within the following condition.
e) 2.5 KV for one minute for the main Power Circuit.
f) 1.5 KV for one minute for all control circuits.

The performance testing shall be carried out with the panel and motor to be supplied by the supplier along with chiller.

7.10 TESTS FOR INSTRUMENTS

7.10.1 Thermowells shall be checked for end connections and tested hydrostatically at 1.5 times the design pressure.
7.11 QUALITY SURVEILLANCE AND INSPECTION

All instruments and hardware used for the entire control system should be of good quality using only standard/ approved components.

8.0 PERFORMANCE GUARANTEE, TOLERANCE AND PENALTIES.

8.1 The Contractor shall guarantee that upon completion and satisfactory commissioning and acceptance of the plant by the purchaser all portions thereof will be in accordance with the requirement of this contract and will be perfect as to design, material, workmanship etc., for a minimum period of one year from the date of the commissioning and acceptance of the plant or 48 months from the receipt of last consignment at site required to commission the chiller unit whichever earlier. This guarantee is in the form of hold up of 5% payment or a bank guarantee for the equal amount valid for the entire guarantee period. The contract shall further guarantee that during the guarantee period, he will repair all defective equipment and work and replace all defective material furnished or installed under this contract free of cost to the purchase.

The contractor shall guarantee the following performance specified as per Sr. No. 4.5 of the water chilling unit.

a) Refrigeration capacity of the machine under operation condition. No negative tolerance on the capacity will be allowed.

b) Chilled water outlet temperature.

c) Condenser cooling water requirement.

d) Power consumption of the water chilling units (KW input to the motor while working under 100% of the load if the stipulated requirements are not fulfilled, the contractor shall make good the deficiency in every case by altering and/or replacing the part or whole equipment free of charge to the purchaser immediately. All replaced part / equipment shall be removed from the site at the contractor’s expenses.

No tolerance on higher side will be allowed on power on power consumption by water chilling package. If the power consumed by the unit exceeds the figure indicated in the offer, contractor would pay to the purchaser a penalty of Rs. 27000/- for each extra KW drawn from the mains for such units while working under 100% of the load (KW input to the motor while working under 100% of the load). Please note that during tender evaluation the same basis will be used for loading on account of power consumption. The quoted figure shall be considered as net and no tolerance will be allowed.

9.0 SPECIAL PROTECTION & CLEANING

9.1 All the equipments shall be neatly finished. All exposed metal surfaces shall be smooth and free from burrs. Finished surface shall be protected against corrosion and mechanical damage.
9.2 Exterior surface shall be thoroughly cleaned to remove scales, rust etc., by using brushing or send blasting as required and than give one shop coat (about 0.15 mm thick) of red zinc chromate primer. They shall than be given a final shop coat of paint as per QA plan.

9.3 Interior surface of all vessels shall be cleaned of all scales, rusts and foreign matter by sand blasting. There after immediately suitable protective coating shall be applied on it.

9.4 Before the equipments are closed, they shall be carefully checked to ensure that all extraneous matters such as rags, tools, rubbish foreign matter, loose scale and dirty weld rod stubs, bolts etc. have been removed. After the interior is cleared and dried by blowing air all opening shall be closed with blank flanges, caps etc. to prevent entry of water, dirt or any other foreign material.

9.5 Final painting of the exterior surfaces of the equipment shall be done.

10.0 SHIPMENT

The supplier shall be responsible for ensuring that all equipment are carefully boxed, crated or otherwise protected for preventing any possible damage during transportation. Flanges shall be drilled as per specification standard and all exposed surfaces shall be thoroughly greased before dispatch. All the nozzle which have to be welded shall be made ready for welding and all be protected by fitting suitable thin metal caps and by tack welding them to nozzle ends prepared for welding in any way. All openings in instruments shall be plugged with suitable plastic caps to prevent entry of dirt and moisture.

11.0 TRAINING

after the commissioning of chiller, a training programme need to be conducted at site on operation and maintenance of chiller explaining the details operation, trips and controls, various protections, precautions, routine PM and surveillance checks of the new chiller unit. Hand on practice to be given to KAPS staff on operation of chiller.

The training should cover the various routine maintenance procedures, Freon and oil charging, Removal / transfer of Freon etc.

Training should also include the calibration procedure for instruments, Fault diagnosis of instruments and cards etc.

12.0 CONTROL ROOM MONITORING

For monitoring the chiller from local control room, latest configuration PC along with necessary operating system software and chiller monitoring software to be provided. The PC should also be provided with printer and CD drive for preserving the data and printing of the history data for performance analysis and fault diagnosis.
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<td>CONTROLLER</td>
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<td>25</td>
<td>PILOT VALVE FOR EXPANSION VALVE</td>
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<td>26</td>
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<td>27</td>
<td>6.6 KV HT, 450 KW MOTOR TERMINAL BOX</td>
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</table>
ANNEXURE – B

SPECIFIC REQUIREMENT SHEET FOR THE CHILLER MOTOR
ANNEXURE ‘A’ OF PP-E-774


2. a) Type of Motor : Squirrel cage hermetically sealed
    b) Type of Starting : D.O.L
    c) Service for which the motor is intended : To drive Chiller Compressor
    d) Design Ambient Temperature : 50°C
    e) Humidity :

3. a) Voltage : 6.6 KV ±10%
    b) KW /HP rating : As required to meet the load under all specified condition.
    c) Frequency : 50 Hz ± 5%
    d) Speed : As required by the driven equipment three
    e) Phases : Three
    f) Type of connection : Star as required by the motor supplier

4. Type of Enclosure
   a) Motor : Semi hermetic
   b) Power Terminal Box : IP- 55
   c) Auxiliary Terminal Box : IP-55

5. Type of Cooling : Compressor motor cooling by liquid refrigerant.

6. Duty : Continuous

7. Type of Mounting : Horizontal

8. Short Circuit Rating of the Power Terminal Box
   I) MVA : 500 KVA (check)
   II) Duration : 0.25 Sec.

9. a) Size of purchaser’s Power supply : Will be informed to successful bidder at the time of approval of the drawing
   b) Type of Cable : XLPE
   c) Size of Purchaser’s cables for space heater external connection. : 2C, 6sq mm. Al. conductor PVC insulated armoured cable.
d) Size of Purchase’s cables for RTD external connection: 2.5 sq. mm copper conductor PVC cable.
e) Separate Terminal box for neutral leads with CT’s: Not Required.

10. Special Requirement pertaining to

a) Bearing: As per clause No. 5.8.2 of motor specification PP—E-774.
b) Painting: To shade 633 of IS – 5
c) Critical speed: Gear drive.
d) Critical speed: More than 130 % of rated speed required.
e) Inspection plugs for Air gap measurement: Required
f) Reverse rotation stop: Anti reverse rotation device to be provided on compressor/ in starter or motor should be designed for reverse rotation up to 15% of rated speed.
g) RTDs: Two per phase
h) Vibration: Shall not exceed limits specified in IS-4729.
j) Acceleration Time of the motor: To suit the requirement as per clause 6.7.2 of motor specification PP-E-774
k) Insulation Details: Class-B.
## TECHNICAL DATA FOR CHILLERS

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<td>Capacity of chiller (each Chiller )</td>
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<td>Chiller Water flow</td>
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<td>Vibration isolation</td>
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<td>Location</td>
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<td>Operational requirement</td>
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