

SPEC. NO.:
NRB/128-
CHW/INRP/2020

**NUCLEAR RECYCLE BOARD
BHABHA ATOMIC RESEARC CENTRE**

TECHNICAL SPECIFICATIONS FOR CHILLED
WATER PLANT

PROJECT:
CHILLED WATER
PLANT (UTILITY
BLOCK-2) AT INRP
TARAPUR

GOVERNMENT OF INDIA

BHABHA ATOMIC RESEARCH CENTRE

TECHNICAL SPECIFICATION

For

Design, Fabrication, Supply, Installation, Integration, testing &
Commissioning of Chilled water Plant.

Doc No.: NRB/128-CHW/INRP/2020

NUCLEAR RECYCLE BOARD

MUMBAI

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

CONTENTS		Page
PART-I	- SCOPE OF WORK & GENERAL INFORMATION	3
PART-II	- SPECIFICATIONS- TECHNICAL REQUIREMENTS	21
PART-II-A	: TECHNICAL SPECIFICATION FOR CHILLED WATER PLANT	22
PART-II-B	: TECHNICAL SPECIFICATION FOR CENTIFUGAL CHILLER	26
PART-II-C	TECHNICAL SPECIFICATION OF MECHANICAL INDUCED DRAFT COOLING TOWERS	52
PART-II-D	: TECHNICAL SPECIFICATION FOR CENTRIFUGAL CHILLED AND CONDENSER WATER PUMPS	73
PART-II E	: TECHNICAL SPECIFICATIONS FOR CHILLED AND CONDENSER WATER PIPING	85
PART-II F	: TECHNICAL SPECIFICATIONS FOR MOTOR	104
PART-II G	: TECHNICAL SPECIFICATIONS FOR ELECTRICAL SYSTEM.	118
PART-II H	: TECHNICALSPECIFICATIONS FOR INSTRUMENTATION & CONTROL SYSTEM	160
PART-III	: ANNEXURE TO FORM OF TENDER	176
PART-IV	: COST STRUCTURE PERFORMA	182

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

PART-I

SCOPE OF WORK & GENERAL INFORMATION

1.0 SCOPE:

This specifications establishes the technical requirements covering design, detailed engineering, procurement of materials, manufacture, assembly of equipment, inspection, shop testing, painting, packaging, safe delivery at site, installation and commissioning and warranty of chilled water plant with all accessories, controls, instrumentations, electric motors, pumps, valves, piping, insulation etc. as per tender specification at project site INRP, Tarapur. The chilled water plant consists of 5 nos. chillers of 1000TR each (4W+1S) with dedicated chilled water pump, condenser pump, cooling towers, electrical and instrumentation panels.

1.1 SCOPE OF SUPPLIER:

The bidder shall quote for the full scope as laid down below:

1.1.1 DESIGN & DETAIL ENGINEERING:

- i) Study of basic inputs provided by NRB, BARC for Chiller plant.
- ii) Design and detailed engineering of Chilled water generation system inclusive of chiller selection, pump selections, cooling tower sizing along with its basin size, pipe sizing, pipe support, electrical and instrumentation requirement in line with Purchaser's requirement. Design and Equipment selection shall be high energy efficient by latest code requirement and latest trend in market.
- iii) Design and detailed engineering of chilled water distributions i.e pipe sizing, booster pump sizing if required, valve sizing, drain, vents, supporting details, instruments selection, technical specification of components etc. from chiller plant outside to various blocks of AHU's and return to chilled water plant is in scope of this tender in line with Purchaser's requirement. Design report along with associated drawings to be submitted for chilled water distribution system for approval by purchaser.
- iv) Detailed design and engineering of the systems/components therein and documentation (Design reports, equipment layout, piping GA, chiller GA drawing, Cooling Tower details, pump sizing, foundation details, pipe supports drawings electrical and instrumentation etc.) as described in various sections of this document.
- v) Generation of detailed flow sheets (with stream flow rates, pressure etc.), P&IDs (showing all equipment, pipe sizes, MOC details, instrumentation and controls and interlocks), piping layout with supports drawings, cable layout and getting approval from the Purchaser.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- vi) Generation of fabrication drawings for pipe supports, chiller components / equipment indicating equipment details & BOQ, and getting approval from the Purchaser.
- vii) As the system is required for operation of nuclear recycle plants, the bidder shall select components of system with reputed make and with proven record for its reliability.
- viii) Design & detailed engineering of chiller foundations, pump foundations, chilled water & condenser water piping support pedestal, cooling tower basin and structure (viz location of foundations & input for foundation size & loads - like forces, moments etc.) & Civil Design Basis Report, Design Calculations, Concrete forming drawings including embedded plates for piping / equipment support and angle edging for opening / trenches edges. Civil works execution is NOT in the scope of the Vendor. However, supervision from supplier during civil works execution is required time to time at critical stage of civil construction to ensure the foundation and other details as per scheme of equipment layout.

1.1.2 SUPPLY, INSTALLATION, TESTING AND COMMISSIONING (SITC):

- i) Scope of SITC includes chilled water generation system along with cooling tower, pumps as mentioned in (ii) of clause no.1.1.1.
- ii) This tender doesn't cover the SITC of chilled water distributions components i.e pipe, booster pump, valves, electrical and instrumentation etc. outside the chiller plant. Design of chilled water distributions is covered as mentioned in point (iii) of clause no.1.1.1.
- iii) Complete manufacture, shop testing, supply, delivery, installation and commissioning of 1000TR of 5 nos. capacity centrifugal chiller unit with HV (6.6KV) motor for chiller compressor along with VFD and its panels, instrumentation for monitoring & controls along with intelligent SCADA for chilled water plant to manage the operation of chilled water plant.
- iv) Load testing of chillers at manufacturer shop as per AHRI guidelines& design conditions.
- v) Manufacturing of chillers and its components, accessories shall be done after approval from purchaser and chiller shall be tested at full load in manufacturer's works as per technical requirement mentioned in this tender document.
- vi) Procurement of materials, manufacture, assembly, inspection, shop testing of induced draft cooling tower shall be done as per technical requirement mentioned in this tender document.
- vii) Complete manufacture, shop testing, supply and installation of condenser and chilled water pumps with the electric motors, VFD and control panel.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- viii) Supply, installation and laying of condenser water piping to and from proposed cooling tower to chilled water plant and chilled water piping with insulation in plant room with necessary valves, pipe supports etc.
- ix) Procurement of raw material, pipes, fittings, valves, supports structures etc., manufacture/fabrication, shop inspection and testing at manufacturers works of equipment and bought out components prior to their delivery at site.
- x) Providing bought out item catalogue, datasheets, test reports, O&M and spare parts manuals, for the purchaser's approval and records thereafter.
- xi) All Control panels including motor with VFD etc. for Chilled water plant and pumps.
- xii) All cabling from MCC to Panel of Chillers, pumps and cooling tower fans.
- xiii) All control and instrumentation, cabling and interlocks, intelligent chiller plant software, control valves etc.
- xiv) Delivery including unloading at stores/ temporary storage area at site, handling, erection (including lifting of material from stores/ temporary storage area) & installation of equipment and associated piping work including valves, fittings & supports.
- xv) Charging of refrigerant gas in the chiller for its final commissioning as per the design requirement.
- xvi) Laying of Raw water and makeup water pipe lines up to the battery limit of chiller plant area as per tender.
- xvii) Painting of pipes and its supports, cooling tower etc. after final installation.
- xviii) Testing and commissioning of system as per site acceptance plan. Vendor shall prepare and sought approval from purchaser for site acceptance plan. Handing over of chiller plant along with relevant documents & drawings for safe, trouble free and continuous operation.
- xix) The system supplied shall complete in all respects, ready for operation with all its auxiliaries, safety feature, instrumentation etc. Any item not specifically mentioned in this specification but nevertheless required for satisfactory operation, maintenance & safety of equipments shall be deemed to have been specified by the supplier and shall be included in the scope of supply of the vendor.

1.1.3 SCOPE OF PURCHASER

- i) Foundation for the chilled water units as per supplier's drawing.
- ii) Foundation for the chilled and condenser water pumps as per suppliers drawing.
- iii) Civil structure for cooling tower inclusive of basin as per civil design drawing provided by supplier.
- iv) Temporary Power supply and water connection will be given at one location for the erection and commissioning of the plant.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

1.1.4 TERMINATING POINT SCHEDULE

- i) Supply, erection and commissioning of equipments of chiller plant inclusive of chillers, pumps, cooling tower, piping, MCC, instrumentation panel and control panel etc.
- ii) All piping with insulation, pipe support connecting to outside the chilled water plant with provision to connect with main header.
- iii) All foundations bolts for installations of equipments along with grouting work.
- iv) All power and control cabling duly wired to control room, local panel and MCC.

2. LIAISON WORK:

The contractor / vendor shall assign responsible engineers to control all aspects of the contract to execute the package as Liaison officer with the purchaser.

3. SYSTEM DESCRIPTION:

3.1. General

Chilled water is mainly required in the plant for air-conditioning purposes. It is also required by process off-gas systems for removing vapor from the off-gas streams. The peak demand of chilled water for various requirements of INRP is around 4000 TR. These requirements will be met from the centralized chilled water plant to be located in Utility Block-2 (Block128)

3.2. Chilled Water System

3.2.1 Generation

The chilled water system of INRP is designed for a maximum operating capacity of 4000 TR. Five (5) nos. of water cooled, centrifugal chilling machines of 1000 TR each are planned. Normally four (4) machines will be operated to meet the requirements. Chilled water will be generated at around 7⁰C temperature with chilled water return temperature at 12⁰C. This system will be provided with class-IV power supply. The system consists of following major equipments/components:

- a) Chiller units: Water cooled, centrifugal, packaged chiller unit comprising of evaporator, compressor, condenser and expansion valves with non-CFC, non HCFC, environment friendly refrigerant R-134a. Compressors will be of water-cooled, single/dual stage, centrifugal, semi-hermetically sealed, gear driven type. Condenser and evaporator will be of shell & tube type heat exchangers with water on tube side and refrigerant on shell side.
- b) Chilled water pumps: Five (5) nos. of chilled water pumps one each for a chiller unit will be provided. The pumps will be of single stage, horizontal split volute casing and centrifugal type.
- c) Condenser cooling water pumps: Five (5) nos. of condenser cooling water pumps one each for a chiller unit will be provided. The pumps will be of single stage, horizontal split volute casing and centrifugal type.
- d) Cooling towers: One (1) no. of induced draft type cooling tower with multiple cells

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

(5 nos.) dedicated for dissipation of heat from condensers will be provided near the utility blocks.

The system and its components will be housed in the chilled water plant room of Utility Block-2 (Block-128). Refer DRG No: A1/IP1/07.01.00/002/GA/RO for flow schematic of chilled water plant & DRG No: A1/IP1/07.01.00/003/GA/RO for General arrangement for Chiller plant area.

3.2.2 Distribution

Chilled water supply header main from the plant room will be routed through service pipe racks. Tapping at appropriate locations will be taken to supply chilled water to various blocks. The chilled water will then be distributed within a particular block through a network of headers and sub-headers. Isolation valves are provided on the headers and sub-headers to facilitate operation & maintenance (O&M) of the equipment's/components and piping network. The return pipe/header main will be routed back to chilled water plant room. All the chilled water piping and valves/fittings are insulated to prevent heat gain by chilled water. Refer figure-IV.B for flow diagram of chilled water system. Make-up water to chilled water system will be provided from the OHTs located on Reprocessing blocks-1 & 2. Cooling tower make-up will be from the OHT located in utility block (Block-145). Refer DRG No: A1/IP1/07.01.00/001/GA/RO for chilled water distribution.

4. LOCATION & SITE INFORMATION:

4.1 LOCATION:

The Project site is Project INRP, Tarapur, here after referred as “Site” is located 120Km north of Mumbai near Tarapur Atomic Power Station. The nearest railway station is BOISAR(WR) and air port is MUMBAI Air port.

4.2 SITE INFORMATION

Sl. No.	Site	INRP, NRB, Tarapur
1	Altitude	Sea Level
2	Environment	Highly Saline
3	Ambient Conditions	
3.1	Max. Temperature	45°C
3.2	Min. Temperature	15°C
3.3	Relative Humidity	60%-90%

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Sl. No.	Site	INRP, NRB, Tarapur
4	Electric Power	415V±10% 3 ph, 50±5% Hz, AC 6.6KV±10% 3 ph, 50±5% Hz, AC for chiller compressor motor. Electricity will be supplied to the vendor on non chargeable basis at nearest single terminal point. The contractor shall make his own arrangements for the supply, erection and dismantling on completion of the work, of his temporarily distribution panel, and other equipment that may require to take the power from the purchaser supply points. The contractors temporarily distribution system shall be subject in every respect to the approval of purchaser, and shall be so arranged to avoid any interference to the operations of the other contractors on the site. The purchaser will not hold himself responsible for the consequence of any unintentional interruptions to the continuity of power supply.
5	Water Supply	Municipal water. Raw water will be supplied to the vendor on non chargeable basis at nearest single terminal point.
6	Compressed Air	Dry oil free air at 4 k/cm2g will be given for erection and commissioning of plant if available at site. Incase if it is not possible to provide compressed air then the contractor shall made arrangement for portable compressor for testing and commissioning purpose.
7	Site Condition	Site will well connected by road for ordinary truck. The Contractor should arrange portable crane to bring the chilling machine from truck to inside chiller room.

5. DOCUMENTS, TECHNICAL LITERATURE INFORMATION TO BE INCLUDED:

The bidder shall submit all supporting information, technical data and specifications as requested in the various sections of these specifications. Technical requirements and part-IV- Annexure to form of tender to the purchaser to make a detailed comparison and evaluation of tender without the need of request for further information from the bidders.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

5.1 DOCUMENTS TO BE SUBMITTED ALONG WITH THE OFFER

- i) General Layout for Plant room and Piping.
- ii) Design data sheet, layout drawing, engineering flow sheet and P&I of the system.
- iii) Selection of various equipment including cooling tower of tendered chilled water plant along with its supporting documents.
- iv) Preliminary outline drawings indicating principal dimensions, wt. of equipment offered and locating piping connections. Cross sectional drawings indicating the assembly of water chiller package and major parts thereof. The supplier shall also furnish details of foundations and loading of all equipment's.
- v) Foundation drawings for chiller unit and pumps.
- vi) Technical literature for chiller unit, cooling tower, pumps, motors, insulation, valves and controls& Instrumentation, bought out items giving overall size, cross sectional details and technical data sheet.
- vii) Supporting documents for chiller to be submitted as follows:
 - a) The firm shall submit selection of chiller along with calculation by software showing all details inclusive of NPLV, IPLV, minimum & maximum flow requirement in evaporator & condenser, COP, power consumption, AHRI certification confirmation for selected model,
 - b) Characteristic curve showing cooling capacity of the package unit at various chilled water temperatures and condenser water inlet along with power consumption part load performance efficiencies and surging limits.
 - c) Single line diagram of lubricating and sealing system.
 - d) Single line diagram of refrigerant cycle pressure temperature at various points.
 - e) Instrumentation and control diagram for whole system.
 - f) Complete description, illustrated literature including manufacturer name size and description of various equipments.
 - g) All calculation details showing correctness of all equipment selection of the chilled water plant.
 - h) Performance and characteristics curves of Motor for chiller like Torque-speed, etc.,
- viii) Supporting documents for cooling tower to be submitted as follows:
 - a) Technical literature for cooling tower giving overall size, cross sectional details and technical data sheet.
 - b) Thermal design calculation for verifying the selection and sizing of cooling tower
 - c) The contractor shall furnish performance curves based on constant L/G ratio under the following conditions.
 - i) For water rate at design condition and $\pm 10\%$ variation.
 - ii) For cooling range at design condition $\pm 20\%$ variation.
 - iii) For wet bulb temperature $+3\%$ and of design wet bulb temperature
 - d) General arrangement drawing of cooling tower.
 - e) Foundation drawings showing Cold water basin and loading details.

<p>SPEC. NO.:</p> <p>NRB/128- CHW/INRP/2020</p>	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	<p>PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR</p>
---	---	---

- f) Characteristic curves of Cooling tower fan.
 - g) Descriptions of shop inspection, testing and quality control facilities.
 - h) All calculation details showing correctness of all equipment selection of the Cooling tower.
 - i) Details of electrical motor, performance curves, thermal load characteristic curves
- ix) Supporting documents for Pumps to be submitted as follows:
- a) General arrangement drawing of pumps and motor with coupling arrangement for all types.
 - b) Sectional assembly drawing of pumps showing part list and material of construction.
 - c) Characteristic curves of pumps showing capacity against head, power efficiency and NPSH pump for design fluid
 - d) Component drawings [detail of stuffing box with normal packing arrangement and mechanical seal (with additional quench gland)].
 - e) Description of shop inspection testing and quality control facilities and quality assurance plan proposed.
 - f) Speed Vs Torque, Speed Vs Load characteristics and Starting current Vs Time characteristic for motors.
 - g) Complete description, illustrated literature/catalogue of equipment offered in specific (pumps/mechanical seal)
 - h) Dimensional drawings of the motor showing terminal boxes and method of termination of purchaser's cables.
- x) Torque –Speed characteristics, capacity variation with VFD control
 - xi) Methodology for executing the tendered work shall be submitted by the vendor along with detailed time schedule of various activities.
 - xii) Details of orders executed / under execution for Chilled water plant in last 5 years ending December - 2019.
 - xiii) All exhaustive data supporting the credit worthiness of the tendered for executing the job in quality and in schedule to full satisfaction of the purchaser. All work lines with supported customer and address, equipment's, supplied, PO cost and field data of the problem faced and solved.
 - xiv) Technical Particulars for chiller unit, pumps, piping & motors (Part-II technical specification).
 - xv) Vendor evaluation Performa (As per format enclosed as Part-III, Annexure-I).
 - xvi) Price schedule (Part IV).
 - xvii) Proof of ability (As per format enclosed as Part III- annexure-IV).
 - xviii) Schedule of deviations (as per Part III- annexure-II).
 - xix) Schedule of special tools (as per Part III- annexure-III).

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

5.2 DOCUMENTS TO BE SUBMITTED AFTER AWARDING THE PURCHASE ORDER:

- i) Design reports of Chilled water generation system inclusive of chiller selection, pump selections, cooling tower sizing along with its basin size, insulation, pipe sizing, pipe support, electrical and instrumentation requirement in line with Purchaser's requirement. Equipment selection shall be high energy efficient by latest codal requirement and latest trend in market.
- ii) Design reports of chilled water distributions i.e pipe sizing, booster pump sizing, valve sizing etc. outside the chiller plant is in scope of this tender in line with Purchaser's requirement.
- iii) Detailed design and engineering of the systems/components therein and documentation (Design reports, condenser and evaporator design, equipment layout, piping GA, chiller GA drawing, Cooling Tower details, pump sizing, foundation details, pipe supports drawings etc.) as described in various sections of this document.
- iv) Generation of detailed flow sheets (with stream flow rates, pressure etc.), P&IDs (showing all equipment, pipe sizes, MOC details, VFD panel, instrumentation and controls and interlocks), piping layout with supports drawings, cable layout for approval.
- v) Generation of fabrication drawings for pipe supports, chiller components / equipment indicating equipment details & BOQ, and getting approval from the Purchaser.
- vi) Design & detailed engineering of chiller foundations, pump foundations, cooling tower basin and structure (viz location of foundations & input for foundation size & loads - like forces, moments etc.) & Civil Design Basis Report, Design Calculations, Concrete forming drawings including embedded plates for piping / equipment support and angle edging for opening / trenches edges. Civil works execution is NOT in the scope of the Vendor. However, supervision from supplier during civil works execution is required time to time at critical stage of civil construction to ensure the foundation and other details as per scheme of equipment layout.
- vii) Detailed piping layout drawings with adequate pipe supports including bill of materials.
- viii) Manufacturing and Delivery Schedule.
- ix) Quality Assurance plan for test/inspection of all the materials used and test/inspection after manufacturing including inter stage for quality control.
- x) Procedures for performance testing of chiller unit and cooling tower at works and site , procedure for testing and commissioning of chilling plant inclusive of cooling tower at site.
- xi) Procedures for motor performance testing of chiller, chiller & condenser pumps, cooling tower fans at works and site.
- xii) Procedure for pipe fabrication and welding of chilled and condenser water piping including insulation.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- xiii) Testing procedures for chilled water and condenser water piping for hydro test, and, D.P. testing of weld passes.
- xiv) Mill test certificates for the materials used for all components of chilled water unit including pumps, motors and piping etc.
- xv) Manufacturing test certificates for pipes, Valves, flanges, strainer welding electrodes, bearings.

In additions to above mentioned documents, the vendor shall once again confirm / submit the final documents as mentioned in clause 5.1 (i to xix)

6. DOCUMENTS TO BE SUBMITTED AFTER COMMISSIONING OF THE SYSTEM:

- i) Performance test reports of chiller units, cooling tower, chiller and condenser centrifugal pumps.
- ii) All approved procedures, QA documents and test reports carried out at works and site.
- iii) Operation and Maintenance manual for chilled water plant& cooling tower including all electrical and instrumentation controls. The manuals should include drawings and performance curves etc. and shall be got approved by the purchaser.
- iv) All technical details related to hardware/software for control and instrumentation of chiller plant along with password to software for operation and modification purpose.
- v) Spare parts list for Chilled water plant, cooling tower, pumps, valves etc to be included in O&M.
- vi) All as built drawings duly approved by competent authorities for Plant room layout and piping layout.
- vii) Guarantee certificate for whole Chilled water plant inclusive of chillers, pumps, cooling tower, VFD, electrical panel, instrumentation panel etc.

7. PRICE

- 7.1. The bidder shall submit the bids conforming to these specifications fully and shall indicate them as mentioned in part-IV of tender. Prices shall be firm and the bids shall be valid for a period of 120 days.
- 7.2. Taxes and levies considered in the offer shall be mentioned separately.

8. PACKAGING AND SHIPMENT

Delivery of the equipment at site shall be the responsibility of the contractor /Vendor. Bidder shall note that packing for shipment shall be in accordance with the instructions outlined in this tender document. The equipment shall be so packed and protected as not to suffer any deterioration, damage or breakage during shipment and storage in a tidal climate. All exposed ferrous metal surfaces shall be covered with a suitable rust preventive compound of an approved make. Large items shall be individually coated.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

9. DEVIATION FROM ORIGINAL TENDER

Bidders finding discrepancies in or omissions from drawings, specifications or other documents or having any doubt as to the meaning or intent of any part thereof should notify the purchaser for the deviations in their offer as per format mentioned in Part III-annexure-II).

10. DESIGN DATA AND CALCULATIONS

The contractor/Vendor shall submit a detailed analysis of his design to purchaser. The analysis shall show all the working up of the design in sufficient detail to enable the purchaser to understand clearly the principals and general calculations involved.

11. APPLICABLE DRAWINGS:

- 1) DRG No: A1/IP1/07.01.00/001/GA/RO – Block Diagram for chilled water Distribution
- 2) DRG No: A1/IP1/07.01.00/002/GA/RO – Flow schematic-for chilled water generation
- 3) DRG No: A1/IP1/07.01.00/003/GA/RO – General arrangement for Chiller plant area
- 4) DRG No: IP1/128/05024831/DWG/001/R0 -Single Line diagram for HT MCC panel
- 5) DRG No: IP1/128/05034831/DWG/001/R0 -Single Line diagram for LT MCC panel
- 6) DRG No: NRB/IP/CW/NA/01 –System Architecture for chilled water supply

12. CONTRACTOR’S DRAWINGS

The contractor shall submit to the purchaser for approval of his plans giving detailed time schedule preferably in the form of PERT/CPM net-work covering the various phases involved in the work, e.g. design, detailed engineering, preparation of drawings, procurement of materials, manufacture, assembly, inspection, testing, delivery to site etc. within two (2) weeks of acceptance of the order.

The contractor/vendor shall submit detailed design reports, layout drawings, technical datasheets for various equipments, equipment drawings, quality assurance plan, material procurement plans, complete shop drawings, all relevant manufacturing and assembly procedures, inspections and test specifications necessary for the execution of work for approval to purchaser as per approved time schedule.

Any work done prior to the approval of these drawings will be at the contractor risk. After these drawings have been duly approved, the contractor shall start the manufacturing of chiller plant equipments.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

All drawings by the contractor shall be in English and the metric system of units shall be used throughout.

All the drawing part lists assembly procedures etc. shall bear a readily identified number e.g. drawing number and each subsequent revise or addition to the drawings or procedure shall be identified by a revision number.

All the drawings shall be clearly marked with the following titles:

“BHABHA ATOMIC RESEARCH CENTRE”

“NUCLEAR RECYCLE BOARD” - PROJECT INRP

13. PURCHASERS DRAWINGS:

The work will be carried out in accordance with the specifications and drawings listed in this tender documents and with such additional or revised drawings that may be issued by the purchaser and with drawing prepared by the contractor/vendor and approved by the purchaser.

14. TRANSPORT LIMITATIONS AND FACILITIES

The contractor /vendor shall be responsible for delivering the equipment to site in packages of sizes and weights that are permissible under the exiting rail, road, sea and air transportation rules.

15. SUB-CONTRACTORS/VENDORS:

The contractors /vendors shall on acceptance of order notify the purchaser in writing of the names of sub-contractors/sub-vendors if any, for execution of work and shall obtain a written consent on the same from the purchaser before commencing the work.

The contractor /Vendor shall be held as fully responsible to the purchaser for all acts and omissions of his sub-contractors/Sub-vendors and of persons directly or indirectly employed by him.

16. SUPERVISION OF INSTALLATION AND COMMISSIONING:

The contractor shall depute his authorized engineer /supervisor to supervise and carry out the erection of the equipment as described in this tender document at site. No erection shall be permitted if supplier’s competent supervisor is not present.

17. QUALITY SURVEILLANCE AND PROGRESS REPORT

All the materials /equipment’s covered by this document shall be subjected to quality surveillance by the purchaser or his authorized representative. The contractor shall allow access at all reasonable times during which manufacture and assembly to the premises in which the work is being carried out and provide the drawings and tooling/ instrument required for testing or inspection purpose.

Produce an inspection plan to the purchaser’s satisfaction and notify him when checkpoints or the plan are imminent so that an inspector may be present if so desired

Inspection and tests shall be carried out as per requirements mentioned in this tender document.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

The contractor at his cost shall remove parts found unsatisfactory as to workmanship or materials, and replaced by parts that are satisfactory.

Waiving of quality surveillance or acceptance or material or equipment by the quality surveyor shall not relieve the contractor of his responsibility for the material and workmanship.

The contractor/Vendor shall submit monthly detailed progress report on the manufacture or assembly of all equipment covered by this tender document in the contractor's or sub-contractor's works. Detailed progress report will include Actual progress in percentage of total work and dates of completion major milestones.

18. TRAINING OF PURCHASER'S ENGINEERS

The purchaser will depute his engineers to the Contractor's/Vendor's work during the manufacturing period for the purpose of familiarization and training with equipment.

19. DELIVERY SCHEDULE:

The bidder shall submit to the purchaser the detailed time schedules indicating various stages involved in the design, design reports, detailed engineering, manufacture, such as preparation of shop drawings, procurement of raw materials and components, fabrication, assembly, inspection, testing, supply to site, installation, site testing and commissioning in the format as given below.

Sr. No.	Activity	Time required (Months)
1.	Design of chilled water plant as per tender, design reports, preparation of design drawings and submission of the same to the purchaser for approval.	
2.	Preparation of piping GA drawings, equipment's drawings, shop drawings, submission of the same to the purchaser for information and comments if any. (It shall be the responsibility of the supplier to satisfy himself that any such additional drawings prepared by him satisfy all the design requirements as indicated in the purchaser's drawings and tender specification.)	
3.	Procurement of raw materials, equipment's i.e chiller, pumps, cooling tower, electrical system etc. and making the entire equipment available for testing at the manufacturer's workshop	
3.1	Chillers with its PLC & VFD panels and its accessories	
3.2	Pumps with its accessories	
3.3	Electrical systems with its components, panels etc.	
3.4	Instrumentation system for chilled water plant inclusive if valves, sensors etc.	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

4.	Shop testing and shipment the equipment to site	
5.	Erection, site testing and commissioning at site	

The bidder's attention is drawn to the fact that no tender shall be considered for acceptance unless the bidder can satisfy the purchaser that he can meet the delivery schedules specified hereunder. The chilled water plant as specified in this tender document shall be designed, manufactured, inspected, shop tested and supplied within 20 months from the date of release of purchase order. The erection, site testing and commissioning of the chilled water plant shall be completed within 10 months from the date of receipt of the chilled water plant at site or date of receipt of intimation regarding the readiness of the site for erection and commissioning of the chilled water plant whichever is later. The delivery schedules shall be strictly adhered to in consultation with the purchaser.

20. GUARANTEE:

- 20.1 Supplier shall guarantee that the goods furnished by him shall be in full accordance with the requirements of the specifications and are new and of high quality. Supplier shall also provide the warranty that the goods are free from defects in design, materials or workmanship.
- 20.2 The supplier shall indicate clearly the terms covered under guarantee / warranty and its period from the date of satisfactory commissioning and handing over of the chilled water plant. The guarantee / warranty shall cover for a period of 12 months from the date of satisfactory commissioning and handing over of the chilled water plant to the purchaser at site.
- 20.3 If, within the expiry of the above stipulated warranty/ guarantee period, the subject goods or any part thereof are found defective because of poor design, workmanship or materials, supplier shall at his own expense, repair or furnish and install replacement parts of proper design, workmanship and materials approved by the purchaser. The guarantee period for replaced parts of repair works shall be the same as above.

21. PAYMENT TERMS: Payment as per rules and regulation of Purchase (NRB).

- 21.1 No advance payment shall be made to the contractor.
- 21.2 Payment will be made on Pro-Rata basis; installments shall be given as follows:
 - (a) 90% of basic cost for supply of Chiller machine (Capacity-1000TR each, 5 Nos., payment on pro-rata basis for each chiller unit) with high voltage compressor motor with HV VFD, unit PLC-HMI based chiller mounted control panel along with all instrumentation and controls inclusive of all valves, sensors, transducers, flow meter, pressure switches etc. as per approved design and tender specification mentioned in Part II and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

(b) 90% of basic cost for supply of Cooling Tower Induced Draft type (No. of cells: Five (5) - 4 Operating x 1 Standby) inclusive automatic chemical dosing system, side filtration etc. inclusive of fan, dosing pumps, electrical motor, VFD, structure and accessories etc. as per approved design and tender specification mentioned in Part II and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

(c) 90% of basic cost for supply of pumps (5 nos. – Chilled water pump & 5 nos. condenser water pump) along with motor, piping, valves, control valve, strainers, piping supports, VFD and all other accessories for system installation as per approved design and tender specification mentioned in Part II and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

(d) 90% of basic cost for supply of electrical system, PLC and intelligent SCADA based system for monitoring and control of entire chiller plant that shall include cooling tower system, chilled water pumps, cables and other accessories etc. required for installation and commissioning of system as per approved design and tender specification mentioned in Part II and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

(e) Balance payment of equipment supply cost and 100% cost towards installation, testing & commissioning of the purchase order will be paid after successful installation, testing and commissioning of entire chilled water system as per the tender specification and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

(f) In case the quoted installation and commissioning cost of equipment is less than 10% of total cost of Purchase order, the difference of the value will be deducted equally from above payment stages (a),(b),(c),& (d) and shall be paid after successful installation, testing and commissioning of entire chilled water system as per the tender specification and approved design datasheets/drawings at site to the satisfaction of purchaser's engineer.

22. FACTORY REPORT:

The bidder shall provide the description and details of company structure, design department, fabrication units and quality surveillance department. This should include the facilities and equipment available for the design, manufacture, supply and erection of chilled water plant of similar nature and capacities. Any special features of the chilled water plant manufactured and special facilities available with the manufacturers for the design and manufacture of the chilled water plant shall be indicated. The bidder should also provide the list, with reference, orders of the chilled water plant of similar kind and capacities to the government organizations especially to the units of Department of Atomic Energy. The bidder shall submit the factory report comprising all above information along with the tender.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

23. SUB CONTRACTS:

The supplier shall not sub contract any part of the work without a written consent from the purchaser. The supplier shall be responsible to the purchaser for all the work of subcontractor if allowed by purchaser.

24. GENERAL INSTRUCTIONS:

24.1. The bidder shall give the cost structure and technical details strictly as per the format as given in our tender document (Part-II, Part-III & Part-IV) failing which the offer may not be considered. Any information (commercial or technical) if bidder wants to add can indicate in the appropriate annexure for which additional sheets can be attached. The bidder shall note that the cost figures shall not be revealed anywhere in the tender document except in Part-IV (Price schedule).

24.2. The purchaser reserves the rights to place the purchase order for chiller plant on any party based on the technical evaluation, vendor evaluation and cost comparison.

24.3. The bidders shall provide the details in vendor evaluation pro-forma as given in Part-III (Annexure-I) of tender document.

25. QUALIFICATION CRITERIA OF BIDDER:

25.1. FINANCIAL CRITERIA:

- i) Average turnover of the bidder in last 3 years ending on 31st March 2020 shall not be less than 25 crores. The firm shall submit signed audited balance sheet for reference along with the bid.
- ii) The firm should not have incurred loss in more than two years during the last five years.
- iii) The firm should not be under liquidation, court receivership or similar proceedings. An affidavit in this regard shall be furnished.

25.2. TECHNICAL CRITERIA:

- i. The bidder shall have experience of supply, installation & commissioning of single chiller or multiple chillers with total capacity of 500 TR or more in single order for chilled water system in last 10 years.
- ii. OEM (Original Equipment Manufacturer) shall have experience of manufacturing a chiller of capacity 1000TR or more in past. The bidder can be OEM (Original Equipment Manufacturer) of chillers or should be an authorized franchise/partner/service provider of OEM for chiller supply, installation & commissioning. The authorized franchise/partner/service provider shall have a letter of understanding with OEM stating

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

“All commissioning support, spares and after sales services will be given by the Principal”.

- iii. The bidder shall confirm that chiller will be tested at manufacturer’s works for full load as per guidelines of AHRI 550/551.
- iv. The bidder should have experience in supply, installation & commissioning of utility services such as chilled water plant, compressed air plant, process system etc. comprising of pumps, cooling towers, piping etc.
- v. The bidder should have experience in engineering and commissioning of equipment or process automation or monitoring of working parameters complete with necessary software and controllers.
- vi. The bidder shall have experienced team members along with organizational structure for execution of similar type projects which involves engineering, planning and procurement, quality assurance and commissioning. The list of personnel to be associated with this assignment shall be given in the Technical proposal with their qualification and experience. The firm shall have minimum following personnel:
 - a) One (1) no Project manager: having qualification of B.E /Diploma holder. Minimum 5 years of experience.
 - b) Two (2) nos. Engineer having qualification of B.E / Diploma holder: Minimum 3 years of experience in execution of chiller plant
 - c) One (1) no. Site Engineer having qualification of B.E / Diploma holder: Minimum 3 years of experience in testing and commissioning of chiller plant

26. GUARANTEES & PERFORMANCE:

- 26.1 The system and its items and components shall have guarantee/warranty for period of 12 months from commissioning and final acceptance.
- 26.2 The entire system shall perform satisfactorily to meet the guarantee requirements specified to the entire satisfaction of the PURCHASER.
- 26.3 The supplier shall provide the warrantee that all items are new and of quality meeting the standards/codes, construction requirements and are free from defects in design, material and workmanship.
- 26.4 The vendor, at his own cost, shall carry out the repair or replacement of defective items or parts during guarantee period.

27. SCHEDULE OF COMPLETION OF WORK:

The chilled water plant with all its accessories and piping as described in part-II of this tender document shall be designed, manufactured, assembled, inspected, and shall be delivered, installed, site tested and commissioned at site within 30 calendar months from the date of award of the purchase order.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

28. DELIVERABLES: Vendor shall deliver chilled water plant system and its subsystem in part to site for installation as per following group:

Sr. No	Item	Description	Qty
1	Design & Detailed engineering	Design of Chilled water plant as per tender document inclusive of chilled water generation and distribution, civil structure design for cooling tower, pipe supports, foundations etc. as per tender technical specifications and guidance drawings issued with the tender. Deliverables are in the form of documents accepted by purchaser.	Lump sum
2	Chiller Unit	Chiller machine with high voltage compressor motor with HV VFD, unit PLC-HMI based chiller mounted control panel along with all instrumentation and controls inclusive of all valves, sensors, transducers, flow meter, pressure switches etc. as per approved design and tender specification mentioned in Part II with charge of refrigerant and lubricating oil	5nos. chiller machines with all its accessories
3.	Cooling Tower	Design, Manufacture, shop testing and supply and delivery of Cooling Tower Induced Draft type inclusive automatic chemical dosing system, side filtration etc. inclusive of fan, dosing pumps electrical motor, VFD, structure and accessories etc. as per approved design and tender technical specifications. No. of cells: Five (5) - (4 Operating x 1 Standby)	1 no. cooling tower of 5 cell with fans, motor VFD and all its accessories
4.	Chilled water and condenser water pump along with Piping and valves	Design, Manufacture, shop testing and supply and delivery of pumps along with motor, piping, valves, control valve, strainers, piping supports, VFD and all other accessories for system installation as per tender technical specification and approved design. (5 nos. – Chilled water pump & 5 nos. condenser water pump)	10 nos. Pumps with pipes, valves, motor, VFD panel and all its accessories.
6.	Electrical system, Instrumentation & Control along with intelligent SCADA for Chiller Plant	Design, shop testing, supply and delivery of electrical system, PLC and intelligent SCADA based system for monitoring and control of entire chiller plant that shall include cooling tower system, chilled water pumps, cables and other accessories etc. required for installation and commissioning of system as per tender technical specification and approved design.	Electrical & instrumentation panels (with all its accessories as per approved design

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

PART-II

SPECIFICATIONS – TECHNICAL REQUIREMENTS

- PART-II-A : TECHNICAL SPECIFICATION FOR CHILLED WATER PLANT
- PART-II-B : TECHNICAL SPECIFICATION FOR CENTIFUGAL CHILLER
- PART-II-C : TECHNICAL SPECIFICATION OF MECHANICAL INDUCED DRAFT COOLING TOWERS
- PART-II-D : TECHNICAL SPECIFICATION FOR CENTRIFUGAL CHILLED AND CONDENSER WATER PUMPS
- PART –II E : TECHNICAL SPECIFICATIONS FOR CHILLED AND CONDENSER WATER PIPING
- PART –II F : TECHNICAL SPECIFICATIONS FOR MOTOR
- PART –II G : TECHNICAL SPECIFICATIONS FOR ELECTRICAL SYSTEM.
- PART –II H : TECHNICALSPECIFICATIONS FORINSTRUMENTATION & CONTROL SYSTEM

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

**PART-II A
CHILLED WATER PLANT
SPECIFICATIONS – TECHNICAL REQUIREMENTS**

1. General

Chilled water is mainly required in the plant for air-conditioning purposes and process system. The peak demand of chilled water for various requirements of INRP is around 4000 TR. These requirements will be met from the centralized chilled water plant to be located in Utility Block-2 (Block128)

2. Chilled Water System

2.1 Generation

The chilled water system of INRP is designed for a maximum operating capacity of 4000 TR. Five (5) nos. of water cooled, centrifugal chilling machines of 1000 TR each are planned. The chilled water system shall be designed for primary variable flow concept. Flow meter and flow modulating valve shall be provided for monitoring and efficient working of chillers. Normally three (3) machines will be operated to meet the requirements. Fourth machine will be put in operation when the peak load arises. Chilled water will be generated at around 7⁰C temperature with chilled water return temperature at 12⁰C. This system will be provided with class-IV power supply. The system consists of following major equipment's/components:

- i) **Chiller units:** Water cooled, centrifugal, packaged chiller unit comprising of evaporator, compressor, condenser and expansion valves with non-CFC, non HCFC, environment friendly refrigerant(R-134A). Compressors will be of water-cooled, single/dual stage (one compressor with single/two stages), centrifugal, semi-hermetically sealed, gear driven type. Compressor shall be provided with VFD to take care of variation of heat load. Condenser and evaporator will be of shell & tube type heat exchangers with water on tube side and refrigerant on shell side.
- ii) **Chilled water pumps:** Five (5) nos. of chilled water pumps one each for a chiller unit will be provided. The pumps will be of single stage, horizontal split volute casing and centrifugal type with VFD.
- iii) **Condenser cooling water pumps:** Five (5) nos. of condenser cooling water pumps one each for a chiller unit will be provided. The pumps will be of single stage, horizontal split volute casing and centrifugal type with VFD.
- iv) **Cooling towers:** One (1) no. of induced draft type cooling tower with multiple cells dedicated for dissipation of heat from condensers will be provided near the utility blocks. Cooling tower fans shall be provided with VFD. Seismic design in civil load shall be considered as per IS 1893.

The system and its components will be housed in the chilled water plant room of Utility Block-2 (Block-128). Cooling tower will be made adjacent to utility block and civil design of cooling tower is in the scope of this tender. Refer DRG No: A1/IP1/07.01.00/002/GA/RO for flow schematic of chilled water plant &DRG No: A1/IP1/07.01.00/003/GA/RO for General arrangement for Chiller plant area.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.2 Distribution

Chilled water supply header main from the plant room will be routed through service pipe racks. Tapping at appropriate locations will be taken to supply chilled water to various blocks. The chilled water will then be distributed within a particular block through a network of headers and sub-headers. Isolation valves are provided on the headers and sub-headers to facilitate operation & maintenance (O&M) of the equipment's/components and piping network. The return pipe/header main will be routed back to chilled water plant room. All the chilled water piping and valves/fittings are insulated to prevent heat gain by chilled water. Refer DRG No: A1/IP1/07.01.00/001/GA/RO for chilled water distribution and **table 1** for AHU load distribution of various blocks for design of system only. This tender doesn't include the procurement and installation of AHU's and chilled water piping distribution after the chilled water generation plant as explained in tender documents.

Refer figure-IV. B for flow diagram of chilled water system. Make-up water to chilled water system will be provided from the OHTs located on Reprocessing blocks-1 & 2. Cooling tower make-up will be from the OHT located in utility block (Block-145). Refer DRG No: A1/IP1/07.01.00/001/GA/RO for chilled water distribution.

This tender covers the design and detailed engineering of chilled water system inclusive of chilled water generation and distribution as scope of design is mentioned in clause 1.1 of Part-I. However, procurement, manufacturing, testing, installation and commissioning of chilled water generation system along with cooling tower system are in scope of this tender. Installation of distribution piping of chilled water outside the chilled water plant to various blocks of facility will be carried out by BARC.

The design of chiller water system shall be carried out with the guidelines provided in this tender document, design standards. The Contractor shall have a single point responsibility for design, detailed engineering, procurement, supply, installation, testing and commissioning of system as per requirement. Conservation of energy & water and optimization of resources with environmental friendliness has been one of the important factors in the design concept. Apart from the latest state of the art technology, energy efficient and fail-safe systems with least maintenance problem is the major consideration for design of systems.

3. DESCRIPTION OF THE SERVICES

The work and services to be rendered by the Contractor shall include, but may not be limited to, the items summarized below:

- a) Preparation and submission of general arrangement drawings, design concept notes along with relevant drawings based on the inputs provided by BARC before detailed design is taken up. This shall include design criteria & procedures, codes & standards, computer software, seismic & safety parameters, quality assurance plans, regulatory compliance, assumptions & presumptions etc. All calculations shall be done in S.I./metric units. Codes & standards to be followed shall be as specified by BARC.
- b) Assess the adequacy of areas provided in the plot plan (for housing chilled plant equipment, panels etc.) and rework the same wherever necessary. Area requirements

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

and building layouts shall meet the stipulations, wherever applicable, of statutory bodies.

- c) Carry out detailed design of civil structure required for cooling tower and condenser pump room as per codes & standards as specified by BARC. Design analysis (both static and dynamic) shall also be a part of this activity.
- d) Work out the BOQ required for various works inclusive of chilled water generation and distribution design. Prepare tender documents along with technical specification to execute the works through sub-vendors. The document shall clearly specify construction/fabrication/installation requirements and scheduling. Quality assurance requirements for various items of works and systems should be specified.
- e) Equipment's/materials/ components i.e. chiller, motor, VFD, valves, SCADA, PLC etc. required for chiller plant shall be procured / fabricated by the supplier only after the approval of the purchaser.
- f) Review and approve the detailing carried out by the contractors. Suggest alternatives, modifications and improvements in line with design requirements. Provide detailed design and drawings of the systems/ structure required during the construction/erection to facilitate the construction of proposed structures. Updating all working & installation drawings on 'as-built'/'as constructed' basis.
- g) Contractor shall prepare design basis reports (DBRs), design reports (incorporating detailed calculations), structural analysis reports. Calculations shall be done in S.I./metric units. Appropriate diagrams, sketches and key layout plans properly cross-referenced shall accompany these reports. Wherever specialist literature, design charts, monograms etc. are used, copies of the same shall be made available with the calculations. Inputs, outputs and validation reports of the Software used in analysis and design shall be made available along with explanatory notes and test examples.
- h) Contractor will develop an overall quality assurance plan for the project. He will also suggest/ supervise and participate in various destructive and non-destructive tests and inspections that need to be conducted at different stages of construction. These activities shall be carried out and implemented in close coordination with BARC.
- i) Contractor shall evolve procedure for design & document review in consultation with BARC. Change control procedures for design, engineering, etc. will also be devised and implemented by the Contractor.
- j) Selection of work method and schedule for the construction and erection at the site shall be indicated by the Contractor. He shall carry out field co-ordination, field engineering, construction supervision, field inspection and verification, review of change notices, quantity certification, recording of measurements jointly with the third contractor, etc. To carry out these activities, the Contractor shall depute his resident engineers at site in adequate numbers as directed by BARC. The Contractor shall ensure that all coordinated working drawings are available for site execution on time including flow of all materials, assemblies, etc.
- k) Complete project management services comprising activity scheduling & work progress monitoring on monthly basis, co-ordination with OEM and other sub-agencies/ vendors etc. shall be provided by the Contractor. Submission of variance

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

reports, milestones achieved, constraints in keeping the project schedules, rescheduling of activities etc. shall be done.

TABLE-1

S.No.	BLOCK NO.	Nos. Of AHUs	Top Most Elevation Of Chilled Water Headers
1	3	3(2R+1S)	14.8 m
		3(2R+1S)	19.8 m
2	4	2(1R+1S)	14.8 m
		6(4R+2S)	20.8 m
		3(2R+1S)	24.8 m
3	5	3(2R+1S)	14.8 m
		2(1R+1S)	19.8 m
		2(1R+1S)	25.8 m
4	6	2(1R+1S)	20.8 m
5	7	2(1R+1S)	29.8 m
6	8	2(1R+1S)	20.8 m
7	9	6(4R+2S)	15.8 m
8	10	2(1R+1S)	14.8 m
9	11	2(1R+1S)	19.8 m
10	12	3(2R+1S)	14.8 m
11	13	2(1R+1S)	24.8 m
12	14	12 (6R+6S)	26.8 m

Note :-

1. The elevation i.e EL 19.58m of outside header is marked on tender drawing.
2. Top most elevation of various chilled water header is given in above table.
3. AHU will be located on floor around 4 mtr below the respective chilled water header.
4. Pressure drop across AHU shall be considered as 10 mWC.
5. Above details are given for design purpose.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

PART-II-B

CENTRIFUGAL WATER CHILLER

SPECIFICATIONS – TECHNICAL REQUIREMENTS

1. SCOPE:

This specifications along with all attached annexure establishes the technical requirements, design, procurement of materials, manufacture, assembly, inspection, shop testing, painting, packaging, safe delivery at site, installation, commissioning and warranty of centrifugal chilled water machines of 1000 TR of 5 Nos with all accessories, controls, instrumentation, electric motors, panels etc. as per the tender specifications at project site INRP, Tarapur. Following are the major components of chiller:

- a) Refrigerant Compressor, with gear box, oil cooling assembly with oil pump and oil heater.
- b) Condenser.
- c) Evaporator.
- d) Semi-Hermetically sealed Motor with VFD.
- e) Thermostatic expansion valve.
- f) Charging of refrigerant and lube oil.
- g) Pump down & refrigerant piping with coupling.
- h) Safety controls & instrumentation including magnetic flow meters for chilled and condenser water.
- i) PLC based controller.
- j) PLC based Main controller with SCADA.
- k) Valves & instruments etc.

The machine shall also include any other device, equipment and accessory not included above but required for making it a complete package giving the required functionality and performance, reliability etc.

2. APPLICATION:

The water-chilling machine is required for supplying chilled water for air conditioning of various areas. The machine shall be capable of working uninterrupted round the clock continuous duty. This unit is required for meet the chilled water demand for air-conditioning and process requirement for Project INRP, Tarapur.

3. GENERAL INFORMATION

It is not the intent to specify herein completely all the details of design and construction of the equipment. However, the equipment shall conform in all respect to high standard of engineering practice and workmanship. It shall be capable of performing continuously with commercially rated output as per warranty clause in a manner acceptable to the

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

purchaser. The purchaser shall have the power to reject any work or material, which in his judgment is not in all accordance therewith.

The specification referred herein completely is not meant to be exhaustive or limiting. The supplier is at liberty to offer state of art equipment meeting or exceeding the specifications. Whenever any clarifications are needed, purchaser's interpretation will be binding.

4. MACHINE HOUSING AND SPACE RESTRICTIONS:

This water-chilling machine together with the accessories shall be installed inside the Block No. – 208 of Project INRP, Tarapur as shown in the Plant room layout Drg. No. A1/IP1/07.00.01/003/PL/R0. However, it may be noted that this is a preliminary drawing and is made for tender purpose only.

It is to be noted that the chillers and chiller pumps is required to be installed in chiller room of 20 mtr x 40 mtr, Cooling tower and condenser pump will be installed in separate building adjacent to chiller room. Civil Design of building required for cooling tower and condenser pump is in scope of this tender. It is important that the tenderer must satisfy regarding adequacy of available space for the installation of this plant along with all equipment and accessories. If any major alteration in the layout as shown in the drawing is involved, the tenderer shall furnish a fully dimensioned layout for chiller unit with all equipment and accessories along with quotation.

5. APPLICABLE SPECIFICATIONS, STANDARDS AND CODES:

Unless and otherwise specified, it is intended that bidder will offer standard equipment for these specifications. All documents listed below of the issue in effect on the date of the pertinent tendering documents constitute a part of these specifications to the extent defined in the subsequent sections of these specs. In the event that certain sections of these specifications or data listed conflict requirements of these specifications, the governing requirements shall be at the criterion of the purchaser.

a)	AHRI standards 550/551-2015	:	Standard for centrifugal water chilling package.
b)	AHRI standards 450-2007	:	Standard for water-cooled refrigerant condensers.
c)	ARI standards 495-2005	:	Standard for refrigerant liquid receiver.
d)	Indian Standard IS-660-2017(Reaffirmed)	:	Safety code for mechanical refrigeration.
e)	Indian Standard IS-659-2017(Reaffirmed)	:	Safety code for Air- Conditioning.
f)	Indian Standard IS-210-2014 (Reaffirmed)	:	Specification for grey iron casting.
g)	Indian Standard IS-1875-		Specification for carbon steel billets, slabs &

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

	2014 (Reaffirmed)		bars for forgings
h)	Indian Standard IS-1239/ASTM A 53/106	:	For carbon steel pipes
i)	ASHRAE standard 22.61	:	Methods for testing for rating of water-cooled refrigerant condensers.
j)	TEMA	:	Code for class C heat exchanger.
k)	ASME Section VIII Div-1	:	Unfired pressure vessels
l)	ASME Section IX	:	Welders Qualification
m)	IS-2002 Gr 2/ASTM A 515 Gr 60/70	:	For carbon steel plates
n)	ASTM A 105	:	For forged carbon steel fittings
o)	ASME E 165	:	Specification for Dye penetrant testing
p)	ASTM A 193	:	for alloy steel bolts
q)	ASTM A 194	:	for alloy steel nuts
r)	ASTM E 1003	:	Specification for Hydro testing
s)	ISO 1940 Gr 2.5	:	for Balancing of rotating parts
t)	VDI 2056	:	Specification for Vibration severity
u)	ASME AG-1	:	Nuclear Air & Gas cleaning for ventilation system.
v)	ASHRAE standard 90.1	:	Energy standards for Buildings

6. PERFORMANCE SPECIFICATIONS:

The machine shall meet the following specifications.

Sl. No.	Item of Performance	:	Specifications
1	Capacity of Chiller	:	1000TR
2	Number of Chiller	:	5 Nos.
3	Refrigerant	:	R-134a
4	Chilled Water Outlet Temp.	:	7.0 ⁰ C
5	Chilled Water inlet Temp.	:	12 ⁰ C
6	Chilled water flow rate	:	600 m ³ /hr
7	Condenser water outlet temp.	:	37.3 ⁰ C
8	Condenser water inlet temp.	:	33 ⁰ C
9	Fouling factor for Condenser	:	0.000176m ² .C/W
10	Fouling factor for Evaporator	:	0.000088 m ² .C/W
11	Max. power consumption	:	Less than or equal to 0.65 IKW/TR at full load & design condition inclusive of VFD loss
12	NPLV	:	Less than or equal to 0.37 IKW/TR at design condition

Water pressure shall not exceed 8 MWC of water in the evaporator and 8 MWC of water in the condenser.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

7. DESIGN REQUIREMENTS

7.1 Construction:

The water-chilling machine shall be a water-cooled centrifugal packaged unit of capacity 1000 TR. The refrigerant used in the chiller shall be of positive pressure, non-CFC and non HCFC, environment friendly with zero ozone depletion potential and minimum global warming potential-Refrigerant-134a. Refrigerant containing chlorine shall not be acceptable.

7.2 Compressors

- a) Compressor shall be water cooled, single/dual stage (single/two stages in one compressor), centrifugal, semi-hermetic, gear driven type, forced lubricated oil cooled type. It shall operate on a positive pressure environmentally Friendly (non-chlorine based, non-CFC and non-HCFC) HFC refrigerant -R 134a. Chillers shall be provided with economizer and other features to maximize the efficiency of chiller in full load as well as part load.
- b) Capacity control shall be accomplished by the use of VFD and inlet guide vanes. The chiller controller monitors the operating conditions and uses a combination of inlet vanes and speed control. The chiller shall able to operate for load variation of 20% to 100% as per AHRI condition. The chiller shall also able to operate at part load of 30% with constant condenser temperature.
- c) An inlet guide vane followed by diffuser assembly at discharge shall be hydraulically/ electrically operated capacity control device closing and opening the guide vanes located in the suction of the compressor. The guide vane activating mechanism shall be designed to operate all the vanes equally for uniform & balanced control of refrigerant to the compressor. Interlocking should be done such that the compressor starts with 0% load and also on stoppage of compressor the vane position should automatically comes to 0%.
- d) The compressor shall be as per the state of art technology and features to ensure maximum economy and flexibly in operation and maintenance. It shall be of proven records of operation in the field for many years.
- e) Its casing design shall ensure accessibility of wearing prone parts viz. Main bearings and thrust bearings etc. for ease of maintenance and replacement. Its lubrication system shall have an emergency system to protect it during spin down period resulting from power failure.
- f) A squirrel cage motor and the coupler system shall drive the compressor drive system. The motor shall operate on $6600 \pm 10\%$ volts, $50 \pm 5\%$ Hz A.C. power supply. The coupler shall match the motor and the compressor speeds and shall be suitably rated to withstand overload conditions. The compressor shall be driven by a motor of adequate capacity, directly coupled through a flexible coupling through a set of gearing for the refrigeration capacity selected with minimum 20% margin in power. The gear drive shall be designed to transmit 20% extra power over that required for driving the compressor under maximum load condition. Insulation of motor and terminal box needs to be design in such a way that no condensation shall happen in motor terminal box.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- g) The service factor selected for gears shall not be less than 2. The gear drive of compressor shall be encased and oil lubricated and cooled. Gears shall be of Ni-Mo alloy steel statically and dynamically balanced, helical double herringbone, balanced thrust type hardened for wear resistance. Couplings shall be designed for safe operation from consideration of Torsional vibration resonance. Gear drive shall be designed for safe operation from consideration of hydraulic and mechanical vibration resonance. They shall be of reputable and approved make.
- h) The impeller and shaft shall be **statically and dynamically balanced** as per ISO 1940 Gr 2.5 or better. The impeller shall be of high strength alloy, fully shrouded. The compressor **vibration level** shall not exceed a level of 3.5 mm/s as per ISO 10816-3(2017).

7.3 The materials of construction shall be as follows.

- Compressor Casing and Volute : Grey iron casting as per IS-210 Grade FG-250
- Impeller : Cast aluminum as per ASTM B-26 SG 70.
- Impeller shaft : Forged steel as per IS 1875 class 3

7.4 Lubrication system:

The compressor shall have an independent lubrication system to provide lubrication to all parts requiring the same. A suitable type & required capacity oil pump consisting of a motor driven oil pump, filter, oil heater, oil pressure regulator, necessary gauges and control by valves shall be provided. Controls shall ensure compressor lubrication before starting the machine and until shaft stops rotating.

The lubrication system shall be of failsafe design. On power failure, it shall provide an adequate oil flow under pressure and should prevent damage that could occur during a spin down period with the oil pump stopped.

7.5 Oil Heater:

Electrically operated oil heaters with thermostats shall be provided in the oil sump. Heater shall be automatically actuated by means of auxiliary contact when the compressor is stopped. Provisions shall be included for controlled heating of the oil. Heaters shall be selected to maintain oil temperatures at sufficient level to minimize affinity for the refrigerant.

7.6 Oil Cooler:

Oil cooling shall be provided by a refrigerant cooled or water cooled external heat exchanger. Heat exchanger located in the evaporator shall not be acceptable.

7.7 Heat Exchangers (Condenser and Evaporator)

Heat exchangers shall be of shell and tube type with water on tube side and refrigeration on shell side. The design, fabrication and testing of all heat exchangers shall conform to the TEMA class C heat exchangers and ASME code for unfired pressure vessel section VIII div. I. The selected design pressure shall have a 10% margin over the maximum working pressure. The maximum working pressure on tube side will be 10.5 kg/cm²g. The specification of condenser and evaporator shall be as follows:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

S.No.	Description	Evaporator	Condenser
1.	Test pressure of tube	17.5 kg/cm ² (g)	17.5 kg/cm ² (g)
2.	Max. pressure drop on water side	8 M WC	8 M WC
3	Fouling factor	0.000088 m ² .C/W	0.000176m ² .C/W
4	Material of Shell	IS-2002 Gr 2 /ASTM A 516 Gr 70	IS-2002 Gr 2 /ASTM A 515 Gr 70
5.	Material of tube	Copper as per ASTM B111	Copper as per ASTM B111
6.	Chiller /Cooling water flow rate	700 m ³ /hr	1000 m ³ /hr
7.	Inlet/Outlet Temp. of water	7.0 ⁰ C /12 ⁰ C	33 ⁰ C /37.3 ⁰ C

Based on 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. Vendors have to enclose the computer selection chart (ARI certified) for selection of the machine for the operating conditions mentioned in the tender.

This system is to be provided with variable primary flow and chiller shall able to operate from 20% load to 100% load smoothly. Maximum and minimum flow of evaporator and condenser shall be submitted with offer for satisfactory functioning of chiller. The quality of water shall be the available water at Tarapur, Biosar Distt Thane.

Water boxes and end covers shall be provided so that each tube sheet can be exposed without disturbing the piping connections. Endless gasket shall be provided between the flanged joints. Marine type water box for condenser & evaporator shall be provided. Hinges for evaporator & condenser dish ends, handles on dish ends shall be provided. Piping connections should be on one side of the water box. It should be possible to open the water box cover without disturbing the piping connection. 2 nos. drain ports with angle valve at the bottom of evaporator & condenser and drain for liquid injection line shall be provided.

Tube supports of adequate strength shall be provided to prevent the tube from sagging and vibrating. The supports shall be as per TEMA standards.

The heat exchanger shell, water boxes, end covers and tube sheet shall be carbon steel conforming to IS-2002 Gr-2/ ASTM SA 516-70.

The tube shall be of copper preferably with fins made integral with the tube. The tube shall be suitably expanded in tube sheets provided at both the ends to avoid leakage of refrigerant or water. The tube inlet shall be flared to avoid disturbances in water flow. Tube to tube sheet joint shall be free from cracking crevices. Minimum thickness of the

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

copper tube after finishing shall not be less than 0.7 mm. Basis for selection of thickness of tube and design shall be submitted for approval of purchaser.

The tubes shall be individually replaceable. The tube shall be integrally finned type seamless copper. Tubes shall be individually replaceable with tube end rolled in to the sheets and sealed.

Side stream filtration system shall be provided in condenser line to clean the water and it shall work automatically based on system parameters. Side stream filter shall be of centrifugal type with self-cleaning provision.

The refrigerant side of each vessel shall be in compliance with the code and indicating a test pressure of 1.5 times the maximum working pressure and shall conform to ASME VIII Div1.

The water side of evaporator and condenser shall be designed, constructed & tested in accordance with ASME section VIII Div-1. The average velocity of water in tubes shall not be more than 2.5 m/sec

The condenser shall be designed for at least 3.0⁰C sub cooling of refrigerant under rated design condition. The water chiller also shall be designed to provide superheat by 3⁰C under rated design condition. Testing and other design features of heat exchanger shall meet the requirement of ASME Section VIII Div-1 heat exchangers.

For standard water selections, minimum allowable refrigerant temperature shall be 0.6⁰C. The liquid refrigerant flow shall be controlled by the self-metering thermal expansion valve. Fixed orifices are not preferred.

Condenser and evaporator shall be in separate shells. Refrigerant flow will be metered by automatic expansion valve that will feed the per amount of refrigerant to the main thermal expansion valve. The liquid line shall have moisture indicating sight glass. Isolation valves and sufficient volume to hold full refrigerant charge in the condenser during servicing should be provided for pump down for refrigerant.

Resetting type spring loaded pressure relief valve according to ASHRAE-15 safety code shall be provided. The condenser shall be provided with dual relief valves equipped with a transfer valve to enable removal of one valve for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel.

The evaporator, suction line and any other component or a component subject to condensing moisture shall be insulated with minimum thickness of 25.4 mm or thickness comes by calculation whichever is greater. Insulation shall be closed cell rubber insulation of approved make. Necessary testing certificates shall be furnished for the quality of insulation. All joints and seams shall be carefully sealed to form a vapor barrier.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

Water pressure differential switches shall be provided on each vessel to act as flow switches and to prevent the unit operation with no flow. These switches shall be factory mounted and wired.

The Evaporators shall be provided with sight glass and shall be adequately insulated.

The insulation on removal heads shall be applied in such a way that it will permit easy removal or replacement of the insulation. In general this shall be accomplished by encasing the insulation in the thick gauge polished aluminum sheet metal boxes bolted together.

Similar insulation shall be done to allied pumps, piping and valves strainers etc. wherever removable insulation is necessary for maintenance.

8.0 PUMPDOWN SYSTEM:

Units operating with a refrigerant that is at positive pressure shall be equipped with a pump out system complete with transfer pump, condensing unit and storage vessel constructed in accordance with ASME code for unfired pressure vessels. The main condenser shall be sized to contain the refrigerant charge at 90°F in accordance with ASHRAE-15.

9.0 MOTOR AND ITS STARTER SYSTEM:

Detailed technical specification of motors, panels and VFDs etc. are given in Part- II F & G of this tender document.

10.0 CONTROL AND MONITORING SYSTEM:

10.1 Control and monitoring system shall consist of the followings:

- a. Each chiller machine shall have its own dedicated control panel, having PLC unit, industrial touch screen human machine interface (HMI) and associated sensors, transducers and final control elements. This panel shall cater all operations of respective chiller.
- b. One PLC controller shall be provided for monitoring status/parameters and control of chilled water pumps, condenser water pumps, cooling towers and valves.
- c. This individual control panel & PLC (of each chiller) shall be connected to central SCADA system for intelligent chiller system remote monitoring & control.
- d. Chilled water system shall be operated from SCADA and/or HMI which shall be backed by PLC based cutoffs and interlocks. Valves & Motors shall be operated from SCADA based operator station. The intelligent SCADA system shall be capable to change set points for system with logging privileges.
- e. PLC-SCADA based control system shall provide complete monitoring of system to operator by means of status feedback, alarms, data logging with time stamping and report generation along with password protections.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- f. Control system shall be provided in such a way that, in case of non-availability of PLC-HMI / SCADA, chiller unit and associated pumps & valves shall be made operable by manual operations under administrative control.
- g. System shall be capable to duplicate important parameters of chilled water system to other SCADA network over Ethernet via fiber optic communication.

Details of control and instrumentation for chilled water plant is mentioned in Part-II-H of this tender.

11.0 FEATURES OF CONTROL SYSTEM: In addition to details mentioned in Part-II-H of tender document, following features to be provided:

- 11.1 The unit controller shall limit the amp drawn of the compressor motor to the rated load amps (RLA) as protection from exceeding maximum allowable amp drawn. The controller shall anticipate any trends above the set point and automatically unload the compressor until the amp drawn is below the set point. The display shall indicate any override amperage condition if the above occurs.
- 11.2 The unit controller shall be equipped with a time clock to allow the end user to program a yearly schedule during the week, weekend and holidays.
- 11.3 The unit controller shall incorporate two short cycle time functions (1) Start-to-start and (2) Stop-to-Start function. The Start-to-Start function shall be capable of being programmed from 20 to 60 minutes. The Stop-to-Start function shall be capable of being programmed from 3 to 20 minutes. Both conditions must be met prior to machine start. Auto restart function after a power failure shall be inhibited.
- 11.4 The unit controller shall incorporate the following START and STOP set points and each shall be individually programmable via the keyboard and display. However provision shall be kept to debar this feature.
 - a) Start-up Differential Temperature: Adjustable temperature above chilled water set point that will actuate the normal startup sequence. The Start-up Differential value shall be adjustable from 1.0 to 10.0°F.
 - b) Shutdown Differential Temperature:- Adjustable temperature below chilled water set point that will cycle the unit OFF after satisfying chiller system load. The shutdown Differential value shall be adjustable from 1.0 to 3.0°F. Password protection must be provided.
- 11.5 The controller shall incorporate oil cooler valve control.
- 11.6 The controller shall be capable of pre emptive control of low evaporator pressure conditions - inhibit loading or unload.
- 11.7 Following temperature sensors, pressure, current, flow transducers shall be provided as monitoring and primary protection devices. These devices shall communicate with the controller.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 11.7.1. Compressor discharge temp.
- 11.7.2. Condenser liquid line temp.
- 11.7.3. Compressor suction temp.
- 11.7.4. Condenser entering water temp.
- 11.7.5. Condenser leaving water temp.
- 11.7.6. Evaporator entering water temp.
- 11.7.7. Evaporator leaving water temp.
- 11.7.8. Oil feed temp.
- 11.7.9. Oil sump temp.
- 11.7.10. Condenser refrigerant Pressure
- 11.7.11. Evaporator refrigerant Pressure
- 11.7.12. Oil sump pressure
- 11.7.13. Oil feed Pressure
- 11.7.14. Evaporator water flow 4-20mA
- 11.7.15. Condenser water flow 4-20mA
- 11.7.16. Motor current (0-5A AC input by purchasers)

- 11.8 Following ON/OFF type safety switches shall also be provided. These devices shall communicate with the controller.
- a. Motor winding high temp.
 - b. Vane closed
 - c. Evaporator DP switch
 - d. Condenser DP switch
 - e. Mechanical High pressure switch
 - f. Antifreeze system response time shall be of the order of 2 sec.

12.0 REMOTE CONTROL AND MONITORING (Intelligent SCADA):

An intelligent SCADA software shall be industrial proven and shall be able to communicate with several PLCs of control system for sending and acquiring data via MODBUS TCP over Ethernet communication. It shall also capable to transmit data to other SCADA server for monitoring and indication.

Network architecture shall meet 'Single element failure criterion' so that failure of any one component in the network does not cause loss of data/control. It shall facilitate the operator to monitor and control the chiller plants i.e chillers, pumps, valves, cooling tower fans, flow, temperature, pressure etc based on refrigeration load in the system with the help of controllers & also SCADA system with the provision of Automatic & manual control from building control room. Instruments, modulating valves for chilled water plant required for local display and automatic control to be supplied by Supplier as per approved design.

Detail technical specification of Instruments and SCADA system for chilled water plant is mentioned in Part-II-H of this tender.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

13.0 INSPECTION AND TESTING AT MANUFACTURER WORKS:

Supplier shall submit QA plan for approval of NRB. Quality surveillance by the purchaser will be carried out at the supplier's works or at the premises of sub-contractor of the supplier as per approved QA plan.

The supplier shall provide inspection to establish and maintain the quality of workmanship in his and his sub-contractors 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 the material furnished conform to the requirement of applicable codes.

All tests and tests procedure posed by the manufacturer shall be submitted to the purchaser for his prior approval. Purchaser shall be notified well in advance of the fabrication and major shop tests of the equipment for the purpose of making general inspection and for making 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 for review. In case the relevant correlating test certificates are not available, the supplier shall arrange to carryout necessary test required by relevant codes at his cost. Following major test will be witnessed by purchaser representative at manufacture works/ sub vendors works as per approved QAP:

1. Fully assembled Chiller testing along with its HT motor, VFD, PLC & its accessories inclusive of performance testing in full load condition and part loads as per tender requirement at manufacturer works
2. Routine LT Motor testing at Motor manufacture
3. LT VFD testing at works
4. Electrical system panel testing
5. Pump performance testing at manufacture works.
6. Valve testing at manufacture works.
7. PLC and SCADA testing of system at works except chiller individual PLC.

13.1 Casting:

Grey iron casting material shall be as per IS-210 Gr. FG- 250. All casting and forging shall be free from flaws and shall be D.P. tested. Test bars shall be cast for physical tests from the same ladle of metal as the castings they represent. Physical tests on test bar shall be carried out and report shall be submitted for approval.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

The casting shall be sound clean and free from porosity, blowholes, hot spots, cold shut distortion and other harmful casting defects.

No repairs shall be carried out without prior intimation to and approval of the purchaser. No welding on C.I. parts will be permitted.

All forging shall be subjected D.P. test at the areas of fillet and change of sections. The testing is to be carried out after machining. Areas which in the opinion of the purchaser will create doubts about soundness of the casting shall be subjected to Dye pentrant test and / or Magnetic particle test.

13.2 FORGINGS

13.2.1 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-Microinches). The test procedure shall be as per ASME boiler and pressure vessel codes. VIII Division. Appendix VI).

13.2.2 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.

13.2.3 The production 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. All forgings shall be demagnetized after carrying out the test.

13.3 WELDING

13.3.1 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.

13.3.2 The supplier shall have all welding procedure, welding equipment's 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.

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

13.3.4 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.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

13.3.5 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.

13.3.6 The Purchaser will call for radiograph of the work if any operator in his opinion is not maintaining the standard of Workmanship at supplier's expense.

13.4 HYDROSTATIC TESTS

All parts subjected to water pressure shall be hydrostatically tested at not 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. Internal test reports for heat exchanger shall be submitted for review to purchaser.

13.5 AIR TEST / VACUUM TEST

All parts subjected to gas pressure shall be air at tested 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 refrigerator unit for a period of 24 hours without losing more than 5mm of Hg. Internal test reports shall be submitted for review to purchaser.

13.6 BALANCING:

Dynamic balancing of impeller rotating assembly shall be carried out as per ISO 1940 Gr 2.5 or better. The vibration level shall not exceed a level of 3.5 mm/s as per ISO 10816-3(2017). Internal test reports shall be submitted for review to purchaser.

13.7 TESTING FOR CONTROL PANELS AND INSTRUMENTS

All bought out items including electric motors, VFD, control panels etc. shall be shop tested

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

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.

The performance testing shall be carried out with the panel and motor to be supplied by the supplier along with chiller. Details of testing requirement of electrical system inclusive of motors, VFD, panels etc. is given in part-II -F&G of this tender document.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

13.8 PERFORMANCE TEST (At supplier's scope)

13.8.1 The test bench for carrying out performance test of water chilling machine shall be certified by ARI. All the water chilling machines shall be tested as per ARI code no. 550/551-2015 at supplier's works in the presence of purchaser's representative for a period of not less than 4 hours at design conditions to demonstrate the satisfactory performance of the machines. This shall include the following.

- a) Determination of cooling capacity at full load and part load (minimum four different loads i.e 25%, 50%, 75% & 90%) at design chilled water outlet temperature and design condenser water inlet temperature for all the chillers.
- b) Determination of NPLV of chiller as per ARI guidelines.
- c) Mechanical Run test of chiller plant.
- d) Demonstration of control of primary variable flow control of chilled water, cooling water based on part load, full load. Based on actual testing, energy saving due to control of flow of chilled water plant shall be evaluated.
- e) Demonstration of operation of various safety controls.
- f) Measurement of power consumption (KW input to motor) at each load.
- g) Vibration level measurement: The compressor vibration level will be measured and shall not exceed a level of 3.5 mm/s as per ISO 10816-3(2017).
- h) All the necessary instruments (duly calibrated) equipment's, 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.

13.8.2 Acceptance Criteria

- a) Chilled water flow rate shall not deviate more than $\pm 5\%$ from the specified condition.
- b) Tolerance on chilled water temperature leaving the evaporator is $44.6^{\circ}\text{F} (+)0\text{ deg.F}, (-) 1\text{ deg. F}$
- c) The water flow rate through the condenser shall be fixed at the guaranteed flow rate furnished by you. No positive tolerance is accepted.
- d) Tolerance on the water temperature entering the refrigerant condenser $91.4^{\circ}\text{F} (+) 1\text{ deg.F}, (-) 0\text{ deg. F}$
- e) While testing of water chilling machine at factory, IKW/TR shall not exceed the guaranteed figures.
- f) No bonus/compensation/benefit shall be given to the bidder under any circumstances if IKW/TR is better than the guaranteed figure and capacity is better than 1000TR.

14.0 CHILLER PLANT TESTING AT SITE:

14 .1. Endurance test at site:

The machine will also be tested at site for capacity, 72 hours endurance test and function test of all accessories.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

14.2. Net Capacity:

The capacity of the machine is 1000 TR net and it does not include the tonnage required for cooling the motor, oil etc.

14.3. Capacity test at site:

Capacity test at site will be conducted at available load and installed equipment's shall be used for making measurements with available accuracy.

15.0 TOLERANCES IN VARIATION OFCHILLER CAPACITY:

Tolerance of (-) 3% viz. (-) 30TR of rated capacity or as per AHRI 550/590 whichever is less shall be applicable for the chilled water unit during testing. If the variation is up to acceptable tolerance as mentioned above, the machine will be accepted. If the variation is beyond acceptable tolerance as mentioned above, the machine will be rejected. In case the capacity of the water chilling machine is more than 1000 TR, no compensation shall be provided by the department.

16.0 REJECTION:

- 16.1. If IKW/TR exceeds the guaranteed figures while testing the water chilling machine at factory.
- 16.2. If chilled water flow rate deviate more than + 5% from the specified condition.
- 16.3. If chilled water leaving temperature is more than 44.6⁰ F(7⁰C).
- 16.4. If condenser water flows is more than the guaranteed flow rate furnished by you.
- 16.5. Water temperature entering the condenser is less than 91.4⁰F(33⁰C).
- 16.6. If the variation in individual chiller capacity is beyond acceptable tolerance as mentioned in clause 18.0, the machine will be rejected.

17.0 SPECIAL CLEANING PROTECTION & PAINTINGS

- 17.1. All the equipment's shall be neatly finished in a workman ship manner. All exposed metal surfaces shall be smooth and free from burrs. Finished surface shall be protected against corrosion and mechanical damage.
- 17.2. Exterior surface shall be thoroughly cleaned to remove scales dirt etc. by using brushing Or sand blasting required and then given one shop of (about 0.15 mm thick) or red or zinc chromate paint. They shall then be given a final shop coat of approved paint.
- 17.3. Interior surface of all the equipment's /materials shall be cleaned of all scales rust and foreign matter by sands blasting. Suitable protective coating shall be applied on its immediately after.
- 17.4. Before the equipment's are closed, they shall be carefully checked to ensure those all-extraneous materials such as tools rubbish foreign matter. Loose scales and dirt's weld rod stubs bolts etc. has been removed.
- 17.5. After the exterior is cleaned and dried all openings shall be closed with blank flanges apes to prevent any entry of water dirt or any foreign matter.
- 17.6. All panels shall powder coated.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

17.7. The centrifugal machines, heat exchangers and other parts, which are likely to be stored for long time at site and subjected to corrosion due to ingress of moisture etc., shall be filled with inert gas. All the nozzles of the equipment's shall be firmly closed to retain the inert gas for long duration.

18. PERFORMANCE, GUARANTEE TOLERANCE

18.1. The contractor shall guarantee that upon satisfactorily commissioning and acceptance of the plant the purchaser all portions thereof will be in accordance with requirement of this contract and will be perfect as to design, materials, workmanship etc. for minimum period of one year from the date of commissioning and acceptance of the plant. Further the supplier shall guarantee that during the guarantee period he will repair defective equipment's and work and replace defective materials furnished or installed under this contract free of cost to the purchaser.

18.2. The contractor shall guarantee the following performance of each water-chilling package.

18.2.1 Chilled water outlet temperature.

18.2.2 Condenser capacity of each machine

18.2.3 Refrigeration capacity of each machine under operating condition.

18.2.4 Power consumption of each water chilling package If the stipulated requirements are not fulfilled the contractor shall correct 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.

18.2.5 The bidder should submit the undertaking for availability of supplying the Spare parts of chiller for the chiller machines for 15 years and Annual maintenance contract (AMC) from the original equipment manufacturer (OEM).

19. LIST OF SPARE PARTS:

Intentionally Left Blank.

20. PROTECTION DURING SHIPPING AND STORAGE:

The supplier shall be responsible for ensuring that all equipment's are carefully boxed, crated, or otherwise protected for preventing any possible damage during transportation. All exposed-machined surfaces shall thoroughly greased before dispatch. All nozzles, which have to be welded, shall be made readily for welding and shall be protected by fitting suitable thin metal caps and by welding them tack to nozzles. Tack welds shall not be damaging the nozzles prepared for welding in anyway. All openings with instruments shall be plugged with suitable plastic caps to prevent entry of moisture and dirt.

21. GENERAL ERECTION REQUIREMENTS:

The contractor shall unload, assembly erect, commission, and start up the entire chilled water plant unless otherwise specified, the contractor shall provide all necessary labour, materials tools and construction equipment.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

22. FOUNDATION/ PEDESTAL FOR CHILLED WATER PLANT i.e chiller, pumps, pipe supports:

Design & detailed engineering of chiller foundations, pump foundations, chilled water & condenser water piping support pedestal, cooling tower basin and structure (viz location of foundations & input for foundation size & loads - like forces, moments etc.) & Civil Design Basis Report, Design Calculations, Concrete forming drawings including embedded plates for piping / equipment support and angle edging for opening / trenches edges. Proper vibration isolators i.e spring isolators shall be provided for chillers.

Civil works execution is NOT in the scope of the Vendor. However, supervision from supplier during civil works execution is required time to time at critical stage of civil construction to ensure the foundation and other details as per scheme of equipment layout. The chilled water plant and pumps shall be installed as per the approved layout.

23. INSPECTION AT SITE:

The contractor or his representative shall be deemed to have inspected and examined to site and surrounding before submitting his tender, shall necessary information as to risks, contingencies and other circumstances which may influence or affect his tender. He should provide detailed installation drawings and follow the plant layout drawing attached herewith the tender.

23 .1. Superintendent and labor:

The contractor shall provide supervision of erection which shall have no limitations.

- a) A competent superintendent shall be constantly at site and shall give his whole time to the superintendence of the erection of works and whose duty shall include the supervision of the loading, assembly, installation, repair, replacement of any damaged components and field alternations required to correct errors in detailing or fabrication, and operating adjustments.
- b) Sufficient number of competent assistants to the erection superintendent shall be employed to provide supervision of number of working sites necessary to complete the work within the time specified.
- c) The contractor shall only employ such persons as are careful, skilled and experienced in their several trades.

23 .2. Notices: Any notice, order, direction or other communication to be given to the contractor under any of the provisions of the purchase order shall without limitation be conclusively deemed to have been received by the contractor if delivered or mailed to the supplier at the addressed mentioned in the purchase order or to the contractor's last known place of business or to his superintendent or his foreman

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 23 .3. **Co-ordination of work:** The contractor shall plan his operations so as to avoid interference with the operations of the purchaser, the general contractor, or of other contractors or sub-contractor at site. The contractor shall organize revision thereof, issued by the purchaser.
- 23 .4. **Lay-out and measurements:** The purchaser will layout basic building lines and establish datum but such layout shall not relieve the contractors of his responsibility for performance of the works. The contractor shall provide equipment for and he shall carry out and check all precision and detailed layouts including setting and alignment of equipment and machinery. The contractor shall protect all survey reference points established by the purchaser and he shall provide sufficient safe and per facilities at all times for layout and measurement of work.
- 23 .5. **Sanitation:** The contractor may have the use, free of charge, of purchasers first aid medical facilities and toilet facilities in the work area to the extent available at site and that too at purchasers option and approval. The contractor at his owns expenses shall provide all other medical and sanitary arrangements.
- 23 .6. **Clean up and observance of safety precautions:** The contractor shall at all times keep the site free from accumulation of waste materials and debris and upon completion of works shall clean away and dispose of all surplus materials, supplies, rubbish and temporary works of whatever nature and kind as directed by the purchaser and shall leave the works and the site clean and tidy.
- 23 .7. The contractor shall be responsible for taking of all safety precautions during the construction and on completion of works, and for leaving the site safe at all times and at the end of each working day and at all times when work is temporarily suspended he shall protect all construction materials, equipment's, facilities for causing damage to the existing property or interfering with the operation of plant when in goes in to service.
- 23 .8. The contractor shall comply with all applicable provisions of all safety regulation, cleanup program and other precautionary measures which the purchaser has in effect at site.
- 23 .9. When insulation is being applied, all machinery, open tanks and/or opening in the tanks, gratings and openings in the working areas shall be covered to prevent loss insulation or debris from fouling such items or falling to floors below.
- 23 .10. A safety supervisor will be stationed on the works and the contractor shall comply with any instruction given by the safety supervision regarding safety, precautions, protective measures, clean-up and any practice which is in the opinion of the safety supervisor may present an available hazard.
- 24. Site Handling & Storage Of Materials And Equipment's To Be Incorporated In The Works:**

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 24.1 The contractor shall unload and place in storage at site, at locations designed by the purchaser, until such times as required all materials and equipment to be incorporated in the works.
- 24.2 The contractor shall be responsible for loading and transportation from the place of storage to the point of installation for the equipment.

25. TRAINING OF THE OPERATORS:

The operators as approved by the purchaser shall be trained by the contractor for efficient and safe operation of the equipment to the satisfaction of the purchaser.

26. WORK DELAY

If there is delay from the connected work from other contractor/Supports, the contractor (who is offering this chilled water plant) will duly adjust his schedule of testing and commissioning in concurrence and approval of the purchaser.

27. TESTING COMMISSIONING

The methodology of testing and commissioning shall be intimated with full procedures, checklists, sequence and any temporary arrangements, needed, list of related agencies involved, and to be intimated, etc. to the purchaser sufficiently in advance (minimum two weeks) for his approval. All measurements, observations shall be taken in the presence of purchaser's representative and shall be certified by the purchaser after his full satisfaction for meeting deigned conditions.

28. SPARES:

The bidder shall consider following mandatory spares in their offer:

Sr. No.	Name of Component	Qty. recommended
1	Shaft seals of Compressor	1 set
2	Bearing of compressor	1 set
3	Gasket & O rings for compressor	1 set
4	Motor bearings	1 set
5	Set of Oil seals	1 set

The supplier may also recommend spare parts list other than listed above.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

**ANNEXURE –I
Technical Particulars of Centrifugal Chiller Water Unit**

Sr. no	Description As Per Tender	Tech. Data of offered Item
1	Machine General Details	
1.1	Capacity (TR) i) Capacity as per condition specified ii) Capacity as per standard ARI condition iii) IPLV value (KW/Ton) iv) NPLV value (KW/Ton) v) Max. IKW/Ton	: : : : :
1.2	Overall Dimensions Of The Chiller Machine (L X W X H)	:
1.3	Total Weight Of Machine	:
1.4	Foundation Details (Attach Drawing)	:
1.5	Noise Level	:
1.6	Vibration Level	:
2	Compressor	
2.1	Manufacturer and Model No.	:
2.2	Type	:
2.3	No. Of Stages	:
2.4	Refrigerant Used and Qty (Kgs)	:
2.5	Suction & Discharge Pressure & Temperature	:
2.6	RPM of the compressor	:
2.7	Critical speed of the compressor	:
2.8	Type Of Drive	:
2.9	If geared: Type of speed increasing gears, gear ratio, AGMA rating, manufacturer's name, model no. Standard followed & materials.	:
2.10	Type Of Lubrication	:
2.11	Name Of Lubricating Oil & Qty. (Ltrs.)	:
2.12	Type Of Lubricating Pump, Power Input And Voltage.	:
2.13	Impeller Diameter	:
2.14	Cooling Arrangement For Oil	:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

2.15	Input K.W. To Motor Of Compressor At a) Full Capacity b) 88% Capacity c) 75% Capacity d) 50% Capacity	:	
2.16	C.O.P. Of Refrigerating Cycle	:	
2.17	Any Built In Vibration Pick Up Are Provided	:	
2.18	If Yes, Detail Of Pick Up	:	
2.19	Materials (Specify Standards Also) a) Impeller b) Casing c) Inlet Vanes d) Shaft e) Shaft Bearings f) Oil Seal Bush	:	
2.20	Detail Of Capacity Control Device	:	
2.21	GD ² value of the compressor impeller in KGM ² at speed	:	
2.22	Type of coupling used (Manufacturers name model etc.)	:	
2.23	Impeller Diameter.	:	
3	Prime Mover (Motor)		
3.1	Make	:	
3.2	Frame Size And Design Code	:	
3.3	Application (Driven Equipment)	:	
3.4	No Of Phases	:	
3.5	Rated Voltage	:	
3.6	Frequency (Hz)	:	
3.7	Permissible Voltage And Frequency Variation Under Normal Running Conditions	:	
3.8	Minimum Voltage Required Under Starting Conditions To Bring Driven Equipment Up To Rated Speed.	:	
3.9	Bhp Actually Required By Driver Equipment Under Specified Operating Conditions.	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

3.10	Stator Winding Conditions	:	
3.11	Starting Current (Percent Of Full Load Current)	;	
3.12	Full Load Current (A)	:	
3.13	Full Load Speed (Rpm)	:	
3.14	Efficiency a) At Full Load b) At $\frac{3}{4}$ Load c) At $\frac{1}{2}$ Load	:	
3.15	Power Factor a) At Start b) At $\frac{3}{4}$ Load c) At $\frac{1}{2}$ Load d) At Full Load	:	
3.16	Accelerating Time With Full Load	:	
3.17	Over Load Capacity	:	
3.18	Overload (Present Of Full Load) That Can Be Carried By Motor Without Lamping Overall Performance.	:	
3.19	Period For Which Overload Applied	;	
3.20	Class Of Insulation	:	
3.21	Winding Temperature Detector (Type, Number And Location Where provided)	:	
3.22	Method Connection To Driven Equipment	:	
3.23	Direction Of Rotation And Corresponding Terminal Designation	:	
4	Motor Starter		
4.1	Solid State Variable Frequency Drive Offered	:	YES/NO
4.2	Ac To Dc Conversation Device	:	
4.3	Advanced Spaced Vector Control Provided	:	
4.4	Switching Devices Used ForPwm Output	:	
4.5	Technique For Reduction Of Motor Harmonics And Torque Ripple	:	
4.6	Controls Inputs Provided	:	
4.7	Programmable Analog Outputs Provided	:	
4.8	Function To Which Digital Outputs Programmable	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

4.9	Fault Protection Provided	:	
4.10	Bypass DOL Starter provided	:	
4.11	Make / Manufacturer	:	
4.12	Model No.	:	
4.14	Interconnection Of Two Types Of Starter Provided	:	
5	Condenser		
5.1	Type	:	
5.2	Model	:	
5.3	Manufacturer	:	
5.4	Total Heat Exchanger Surface Area (M ²) a) Internal b) External	:	
5.5	Total Heat Rejection At Rated Load (Kcal/Hr)	:	
5.6	Cooling Water Requirement a) Quantity (M ³ /Hr) b) Inlet Pressure (Kg/Cm ²) c) Inlet Temperature °C d) Outlet Temperature °C e) Pressure D (M Of We) f) Velocity In Tubes (M/S)	:	
5.7	Tubes And Fins a) Dia Of Tubes b) Inner Dia (mm) c) Outer Dia.(mm) d) Fins height e) Number of fins per cm f) Whether integral fins provided (Yes/No) height and pith of the fins (mm) and no. of fin/cm g) Length h) Number Of Tubes i) Whether Integral Fins Are Provided j) Material (Specify Standards) k) Tubes l) Fins	:	
5.8	Shell Sheet Materials (Specify Standards) thickness Of Plate	:	
5.9	Dimensions Of Condenser (Mm)	:	
5.10	Heat, Removable?	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

5.11	Overall Coefficient Of Heat Transfer	:	
5.12	Fouling Of Passes	:	
5.13	Number Of Supports For The Tube Bundle Inside Condenser	:	
5.14	Design Pressure (Kg/Cm2) a) Shell Side b) Tube Side	:	
5.16	Weight In (Kg) a) Operating b) Empty	:	
6	Evaporator	:	
6.1	Type	:	
6.2	Model	:	
6.3	Manufacturer	:	
6.4	Total Heat Exchanger Surface a) Internal b) External	:	
6.5	Total Heat Gain At Rated Load (Kcal/Hr)	:	
6.6	Chiller Water a) Quantity (M ³ /Hr) b) Inlet Temperature (°c) c) Outlet Temperature (°c) d) Inlet Pressure (Kg/Cm ² g) e) Pressure D (M Of WC) f) Velocity In Tubes (M/Sec)	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

6.7	Tubes And Fins a) Dia Of Tubes b) Inner Dia (mm) c) Outer Dia.(mm) d) Fins height e) Number of fins per cm f) Whether integral fins provided (Yes/No) height and pith of the fins (mm) and no. of fin/cm g) Length h) Number Of Tubes i) Whether Integral Fins Are Provided j) Material (Specify Standards) k) Tubes l) Fins	:	
6.8	Dimensions Of Evaporator (mm)	:	
6.9	Shell Sheet Materials (Specify Standards)	:	
6.10	Thickness Of Plate	:	
6.11	Dimensions Of Condenser (Mm)	:	
6.12	Heat, Removable	:	
6.13	Overall Coefficient Of Heat Transfer	:	
6.14	Fouling Of Passes	:	
6.15	Number Of Supports For The Tube Bundle Inside Condenser	:	
6.16	Design Pressure (Kg/Cm ²) a. Shell Side b. Tube Side	:	
6.17	Weight In (Kg) a. Operating b. Empty	:	
7	Control System		
7.1	Architecture (Attach Drawing)	:	
7.2	Block Diagram (Attach Drawing)	:	
7.3	Parameters Monitored (Enclosed List)	:	
7.4	Trips / Alarms Provided (Enclosed List)	:	
7.5	Controls Provided (Enclosed List)	:	
7.6	No Of Levels Of Password Security (Enclosed List)	:	
8.	General		

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

8.1	Charge Of Refrigerant Included In The Cost Of The Machine (Yes/No) till final commissioning of machine at site	:	
8.2	Vibration Pad/ spring Isolators Provided	:	
8.3	Base Plate Support Provided Yes/No	:	
8.4	Furnish an assurance regarding servicing and spares facility for the machine for 15 years in the case of award of contract	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

PART-II C

SPECIFICATION – TECHNICAL REQUIREMENTS OF MECHANICAL INDUCED DRAFT COUNTER FLOW COOLING TOWERS

1. SCOPE

This specifications establish technical requirements covering, design, engineering, preparation of detailed drawings, procurement of materials, manufacture, assembly, inspection, shop testing, painting, packaging, safe delivery at site, unloading, installation, commissioning, testing and performance guarantee of Mechanical induced draft counter flow type cooling tower consisting of 5 Cells (4W x 1S) of heat rejection capacity of 15.12×10^6 Kcal/hr and heat rejection capacity of each cell 3.78×10^6 Kcal/hr.. The Cooling tower shall be complete with all accessories, controls, electric motors, piping, valves, etc. as per the tender specifications and delivery to Project INRP, Tarapur.

- 1.1 Design, engineering, procurement of all materials, Complete manufacture, assembly, shop testing, supply, delivery at site, unloading, installation, commissioning and acceptance test of mechanical induced draft counter flow cooling tower as per specification along with the accessories as listed below.
- 1.2 Hot water piping including distribution valves for each cell of shall be terminated at one point outside the tower with flange and counter-flange and with necessary gasket and hardware.
- 1.3 Provision for adequate size drain for each sump with suitable piping up to nearest drain.
- 1.4 Provision for adequate size overflow for each sump connection
- 1.5 Anchor bolts for fixing the cooling towers.
- 1.6 The suction embedment pipe of adequate size to each sump ending with flange and counter flange and nut, bolts shall be included in the supply.
- 1.7 2 nos. SS 304-wire screen of 10 meshes complete in SS construction with guide channels for each cell.
- 1.8 2 nos. ladder from Floor level to Hot water deck.
- 1.9 Safety rail around the cooling tower with suitable anchoring
- 1.10 The suitable Electric Motors for fans: 5 nos.
- 1.11 The vibration cut out switch with provision for alarm for each fan.
- 1.12 Low lubricating Oil Level Switch for each gear reducer.
- 1.13 Design & detailed engineering of cooling tower basin and cooling tower structure, Preparation of Civil Design Basis Report, Design Calculations, Concrete forming drawings including embedded plates for piping / equipment support. Preparation of detailed engineering drawings; approval of all drawings, QA plans; manufacturing schedules purchaser's approval and records thereafter.
- 1.14 Civil works execution is NOT in the scope of the Vendor. However, supervision from supplier during civil works execution is required time to time at critical stage of civil construction to ensure the foundation and other details as per scheme of equipment layout.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 1.15 Design of RCC basin, Preparation of detailed engineering drawings; approval of all drawings, QA plans; manufacturing schedules purchaser's approval and records thereafter.
- 1.16 Erection, testing/ commissioning of cooling tower at site.
- 1.17 Performance Guarantee of cooling tower.
- 1.18 Set of startup and commissioning spares.
- 1.19 Set of standard special tools
- 1.20 Painting: All exposed iron and steel components shall be thoroughly painted as per specifications.

2. APPLICABLE SPECIFICATION, STANDARDS AND CODES:

The design, materials, construction, manufacture, inspection, testing and performance of the cooling tower shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The cooling tower shall also conform to the latest applicable Indian or British standards and publications of the Cooling Tower Institute. All documents listed below of the issue in effect on the date of the pertinent Tendering Documents constitute a part of this specification to the extent defined in the subsequent sections of this specification. In the event the certain requirements of the specification, the governing requirements shall at the criteria of the purchaser.

- CTI Test Code ATC-105 : Code for Testing cooling towers.
- BS 4485 part-2 : Method of test and acceptance of cooling tower
- BS 4485 Part-3 : Thermal and functional design of cooling tower
- IS-2372 : Specification for wood treatment
- IS-1363 & IS-1367 : For all threaded fastners
- IS-823 : Welding requirements
- IS-102 : Ready mixed paint, red lead non setting priming.
- AMCA Codes Section : Testing of Axial fans
- ASME Section IX : Procedure for welding and welders Qualification
- IS-1239 & 3589 : For piping
- AGMA : American Gear manufacturing Association.
- ATP : Acceptance Test Procedure
- IS 2633 : Preece test for uniformity of GI coating
- IS 2629 : Adhesion test for GI coating
- IS 3202/4759 : Coating thickness testing (Magnetic)

3. DESIGN DATA AND PERFORMANCE OF THE COOLING TOWER:

Sr. No	Description	
1	Total heat rejection (Kcal/hr) (Operating)	15.12 x 10 ⁶
2	Heat rejection per cell (Kcal/hr)	3.78 x 10 ⁶

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

3	No of cells	Five (5)
4	Operation philosophy	4 W x 1 S
5	Water flow rate per cell (CMH)	900 CMH
6	Design hot water inlet temperature	37.3°C
7	Design cold water outlet temperature	33.0 °C
8	Design ambient wet bulb temperature	28.2 °C
9	Design maximum ambient temperature	45 °C
10	Relative humidity	96%
11	Wind velocity for performance	13 Km/hr
12	Wind velocity for design of structure	180 Km/hr

4. COOLING TOWER – TECHNICAL REQUIREMENTS

4.1 GENERAL REQUIREMENTS

- 4.1.1 The cooling tower is envisaged for cooling of condenser water of chilled water plant System.
- 4.1.2 The proposed cooling tower will be located adjacent to chilled water plant on the civil structure specifically constructed for cooling tower at ground level. The bidder shall take this into account while design the cooling tower and also for erection of the cooling tower.
- 4.1.3 Design & detailed engineering of cooling tower basin and cooling tower structure, Preparation of Civil Design Basis Report, Design Calculations, Concrete forming drawings including embedded plates for piping / equipment support. Preparation of detailed engineering drawings; approval of all drawings, QA plans; manufacturing schedules purchaser's approval and records thereafter. Cooling tower structure will be common for chiller plant cooling tower and compressor system cooling tower. Loads regarding compressor cooling tower will be provided during detailed engineering for structural design of civil structure of cooling tower. However, cooling tower for compressor system is not in scope of this tender.
- 4.1.4 Civil works execution is NOT in the scope of the Vendor. However, supervision from supplier during civil works execution is required time to time at critical stage of civil construction to ensure the foundation and other details as per scheme of equipment layout.
- 4.1.5 The cooling tower shall be designed for continuous operation throughout the year.
- 4.1.6 It should have minimum maintenance design criteria using inert materials for both functional and structural components. Routine maintenance should be minimum and easy. It should have very good maintainability.
- 4.1.7 The area available for installing the cooling tower to accommodate 5 cells is approx. 7 Mtrs wide and 30 Mtrs long including the space for cold-water basin. The bidder shall take this account while sizing the cooling tower.
- 4.1.8 Perimeter handrails: Handrails around the cooling tower on top made from Pultruded FRP shall be provided.
- 4.1.9 Suitable access doors shall be also provided in casing and plenum area partition walls, drift eliminators.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.1.10 2 nos Access ladder for cooling tower of Pultruded FRP shall be provided to reach top of cooling tower.

4.1.11 There shall be walkway inside the basin in plenum area.

4.2 DESIGN REQUIREMENTS:

4.2.1 The cooling towers shall be mechanical induced draft counter flow and shall meet the duties as specified. It will ensure more wetted surface, uniform water distribution and higher heat transfer rate.

4.2.2 In multi cell construction, each cell shall be identical with the other cells of the cooling tower in all respects. The total heat load and flow shall be equally shared amongst the number of operating cells.

4.2.3 The design shall ensure maximum volume of air movement at lower applied horsepower.

4.2.4 All the five cells of the cooling tower shall be constructed on a common RCC cold water basin. Each Cell is provided with dedicated cold-water basin and intake screen and pipe EP's for Outlet, drain. This facility will ensure complete isolation of each cell for maintenance and cleaning without affecting the operation of other cells.

4.2.5 Structural frame work for cooling tower shall be of Pultruded FRP inclusive of cooling tower superstructure, structural casing, structural column, cooling tower fan deck, louvers, fill support material, louvers support etc. and designed for operational load and wind load of projected area in any horizontal direction.

4.2.6 The column anchor plates shall be fabricated from stainless steel along with fasteners.

4.2.7 The FRP members shall be constructed of fire retardant, self-extinguishing resin system with a flame spread rating of 25 or less. The FRP member shall be protected from UV degradation by the use of surfacing veils and UV stabilizers incorporated in resin system.

4.2.8 The Pultruded FRP members to be used in construction of this tower shall be classified, defined and specified as a minimum per CTI 137.

4.2.9 FRP classification: Type II, III & IV Pultruded shapes are acceptable with surface veils to provide long term UV protection.

4.2.10 Resin Grade: Grade1 or Grade 3 are acceptable for the structure with a flame spread rating of 25 or less.

4.2.11 Fans:

a) Fans shall be propeller fans with aerofoil blades and shall run smooth without undue noise and vibration.

b) The cooling tower shall be sized and selected by the bidder to accommodate additional flow of 10% of the design flow and also the 10% of additional heat load per cell.

c) Fan tip speed shall not exceed 60.96m/sec.-(1200 FPM).

d) Entire fan blade assembly shall be statically and dynamically balanced/smooth to grade ISO 1940 Gr. 6.3 and vibration free operation.

e) Fan cylinder shall be made of Pultruded FRP.

f) The fan drive shall be either direct drive or gearbox type. Gear drives shall be enclosed type with one class of higher duty and shall operate in oil bath considering the factor of safety 2.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.2.12 Gear Reducer: It will be designed for minimum service factor of 2 as per AGMA standard and shall be suitable for cooling tower service. Gear reducer shall be of spiral bevel type. All gear drives shall be of enclosed type and shall operate in oil bath. It shall have high efficiency at the selected duty. Remote oil level indicators fill and drain line shall be provided the output shaft and bearings shall have a life of B10 or 100000 hours where the shaft is subjected to a bending moment of 3 times the normal torque requirement for fan. The drive shaft shall have flexible couplings at the driving and non-driving ends. The flexible coupling bushings shall be of rubber. Drive shaft shall be dynamically balanced at rated speed. Service factor of 2.0 shall be considered for gear reducers.

- a) Electric motor shall be suitable to operate on 3 phase A.C. supply and motor rating shall be at least 115% of fan power requirement at design conditions.
- b) The spray nozzles shall be selected with minimum pressure drop and shall not exceed 4 mtrs of water column.
- c) Drift losses in the cooling tower shall be less than 0.05%.
- d) **Vibration:** The vibration measured on the fan deck shall not me more than latest codal requirement as per approved design.
- e) Noise level produced individually or collectively shall not exceed 85 dB(A) above threshold level when measured at a horizontal distance of 15 mtrs from the nearest face of tower and 1.5 mtrs above ground level.
- f) Hot water headers shall be designed for velocity of water at 2 – 2.5 m/s and all the flanges shall be ANSI Class 150 rating.

4.3 DESIGN FEATURES FOR CONSTRUCTION AND REQUIREMENTS:

4.3.1 BASIN & SUMP:

The basin & sump for cooling tower shall be of reinforced cement concrete construction. The concrete structure shall be designed as per IS: 456, IS: 3370 (latest edition) and other relevant IS: Codes and as per enclosed specifications. The basin including sump shall have a clear depth of 600 mm & about 1500 mm of the suction sump. The basin shall be divided into 5 components by providing concrete partition wall designed for pressure on one side only. The top of basin and sump shall be tapered inside. The basin shall have adequate provision for the following and these facilities shall be provided for each compartment.

- a) Sump outlet for pump suction of adequate size HDG MS pipe with puddle flange.
- b) Drain off and sludge removal arrangement with piping and flanges etc. of Hot Dip Galvanized Steel (HDG MS).
- c) Water level controller with solenoid valve and multiple Stainless-steel electrode probes on basin shall be provided to provide control of water makeup valve, low- and high-level alarms and output for shutoff of pump on low level.
- d) Overflow arrangement of adequate size HDG MS pipe with puddle flanges (150lb ratings)

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- e) Top of the suction sump shall be covered with treated timber tongue & groove planks of 1.5” thick.
- f) The 2No. Screens at the suction in the sump of each cell shall be of the rectangular shape type made out of SS-304. A suitable strainer guide of Stainless steel shall be grouted on the sump for fixing of screens. The effective velocity through the strainer screen shall not be more than 0.3 M/sec no. of screens provided shall be two in addition one spare screen shall also be supplied.
- g) All design calculations for all civil works shall be submitted to the purchaser for approval.

4.3.2 AIR INLET LOUVERS:

Air inlet louvers shall be suitably designed and supported and arranged that there will be minimum restrictions to air flow and prevent down coming of water from splashing out of the tower. The material of construction shall be of Pultruded FRP of minimum thickness of 6 mm. The louvers shall be properly supported and sufficiently close centers to prevent their sagging more than 12 mm under worst condition.

4.3.3 FRAME WORK

Structural frame work for cooling tower shall be of Pultruded FRP inclusive of cooling tower superstructure, structural casing, structural column, cooling tower fan deck, louvers, fill support material, louvers support etc. and designed for operational load and wind load of projected area in any horizontal direction. The column anchor plates shall be fabricated from stainless steel along with fasteners.

The FRP members shall be constructed of fire retardant, self-extinguishing resin system with a flame spread rating of 25 or less. The Pultruded FRP members to be used in construction of this tower shall be classified, defined and specified as a minimum per CTI 137.

4.3.4 CASING:

Casing shall be of corrugated FRP applied vertically and are lapped to shed water. They will be lapped and sealed at all joints. FRP louvers shall be located on wide centers, supported by tower columns on corrugated and wall casing. It shall be made water tight against leakage of the cooling tower to the outside. It shall be designed such a way that if it requires to replace the fill without dismantling the cooling tower. All structural joints are bolted and shear plates or split rings connectors shall be used wherever necessary. The casing shall be bolted at lapped joints with Stainless steel fasteners preferably with SS 316.

4.3.5 FILL:

The fills shall be film type, in honeycomb design with flute size 19 mm which provides the wetted surface and air turbulence necessary for proper heat transfer while minimizing resistance to air flow and low fan HP. The fills shall be made from Virgin PVC, UV stabilized C10-19 fill of MM Aqua and approved by CFPRI, Chennai.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.3.6 FILL SUPPORTS

Fill shall be properly supported at span not exceeding 610mm and no grids shall be used as a common support for neighboring by a state. Material of construction for grids/supports is Pultruded FRP.

4.3.7 DRIFT ELIMINATORS:

Drift eliminators shall be rigid virgin PVC designed to minimize entrainment losses to 0.05% of the circulation rate with lowest pressure drop. Drift Eliminator shall be of herringbone pattern supported on Pultruded FRP of “C” type aerofoil rigid PVC blades with PP spacers. Drift eliminators shall be made from Virgin PVC, D 31 of MM Aqua and approved by CFPRI, Chennai

4.3.8 PARTITION WALL:

Partition wall shall be provided from basin top to the bottom of fan deck to permit each cell to be taken out of service without affecting the operations of the other cell. The partition wall shall be of 6 mm thick FRP.

4.3.9 ACCESS DOORS:

All parts subjected to periodical maintenance and inspection such as filling, drift eliminators, fan etc. shall be readily accessible and easily removable. Access doors shall be provided at the basin level though casing side in each cell of Pultruded FRP in each fan deck.

4.3.10 FAN

Fan shall be propeller fans with aerofoil design with at least six blades made from cast aluminum alloy. Fan blades shall be removable and pitch should be adjustable; material of construction for hub shall be close-grained cast iron or stainless steel.

4.3.11 FAN CYLINDER CUM RECOVERY CONE:

Fan cylinder cum recovery cone shall be made from Pultruded FRP and shall be 5 mm thick minimum. It will have aerodynamic contour to allow close tolerance and less resistance to air passing through the tower. Fan cylinder shall have an extended stack of venturi shape to attain conversion of velocity pressure to static pressure. The height of the stack shall be such that the recirculation effects of air shall be reduced to minimum possible. Fan cylinders shall include hot dipped galvanized steel fan guard's in sturdy construction.

4.3.12 FAN DRIVE

Fan drive shall be either direct or through right angle gearbox for positive performance. Belt drives are not acceptable.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.3.13 GEAR BOX

Gearbox shall be of spiral bevel type with gears and bearings selected for 5-Years life. Double oil seals are preferred to minimize the leakage of oil or ingress of moisture. Lubricating oil used shall be of turbine type to avoid emulsification due to water connection. Gear shall be made up Nickel Molybdenum (Ni-Mo) alloy. Gear shall be balanced dynamically. There shall be an oil line provided of G.I. for filling the gearbox however the flexible connection to gearbox shall be of S.S. Hose. Lubrication, grease nipples and oil level indicators shall be taken to the outside of the fan to facilitate servicing. .

4.3.14. DRIVE SHAFT

Drive shaft shall be of tube flange assembly Material of construction of drive shaft shall be preferably EN-8. Coupling shall be made from malleable iron. Flexible elements shall be neoprene that can, resist moist surrounding. Drive shaft shall be provided with suitable guard. Entire fan blade assembly shall be statically and for dynamically balanced/smooth to grade ISO 1940 Gr. 6.3 and vibration free operation.

4.3.15 SUPPORTS AND GUARDS:

The motor and gear reducers shall be supported on stainless steel members with all necessary bracings to prevent deflections, misalignment or excessive vibrations. The motor and speed reducer shall be accurately aligned on the supports and securely bolted to it with stainless steel bolts; nuts split washers and steel washers. All moving parts of the fan and motor shall be properly guarded for safety reasons.

4.3.16 VIBRATION CUT OUT SWITCH:

A vibration cutout switch with provision for alarm to stop the electric motor of fans in the event of high vibration shall be provided. The switch must be provided with reset device to set its action at the desired level of vibration above the normal. The switch shall be suitable to operate on single phase A.C. Supply 230 Volts. Potential free contact shall be provided for indication in control room for operation and tripping.

4.3.17 AUTOMATIC LOW OIL LEVEL SWITCH:

An automatic float operated lubricating oil level control switch for each gear reducer shall be provided to protect the gear reducer in the event of low lubricating oil level. The switch shall be suitable to operate on single phase A.C. Supply 230 Volts.

4.3.18 PIPING:

The piping shall be Carbon steel Hot dipped galvanized with minimum Galvanizing coating of 120 microns as per the relevant standards and the pipes shall be as per ISI-1239 & ISI-3589 and shall be so done that each individual cell of the tower is possible to be isolated for maintenance testing, operation, etc. All flow control valve shall be of reputable brand liberally designed for the duty and shall be cast iron body and stainless steel stem.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.3.19 HOT WATER DISTRIBUTION SYSTEM:

The hot water distribution shall be pressure spray type made out of MS Hot dip galvanized main header and branch pipes which are bolted to top of the tower structure.

4.3.20 CASING COVERS:

The hot water distribution or top casing covers and cold-water basin covers shall be of 5mm thick aluminum chequered plates. These plates shall be removable type with handles and duly secured to the framework of the tower.

4.3.21 SPRAY NOZZLES:

Hot water distribution system shall be through non-clogging metering orifices to distribute metered flow through jet spray. The nozzles shall be selected based on tower area, depth of space above fills and shall be spaced and arranged to obtain uniform spray over entire cooling tower area with least resistance. They shall be highly resistant to temperature and adverse weathering conditions. The nozzle shall be MM Aqua Dek-Spray solid rectangle type and shall be made from ABS. The nozzle shall be fixed to the hot water distributor through suitable adopters.

4.3.22 AUTOMATIC CHEMICAL DOSING SYSTEM: Automatic chemical dosing shall be designed for cooling tower as per the requirement to maintain the quality of cooling water. This system shall be supplied, installed and commissioning with all sensors for conductivity (electrode less sensor), PH sensor etc along with electronic dosing pump, chemical tanks and controller. This system shall compatible with main controller software.

4.3.23 SIDE STREAM FILTRATION: Side stream filtration system shall be provided in condenser line to clean the water and it shall work automatically based on system parameters. Side stream filter shall be of centrifugal type with self-cleaning provision and design of side stream filtration shall take care of system requirement. The system shall be designed for 8- 10% of total flow.

4.3.24 HARDWARE AND STEEL COMPONENTS:

All hardware used shall be galvanized steel but nails used shall be screw shank ANSI – 316 S.S. only. All steel parts should be hot dip galvanized after fabrication.

5. ELECTRICAL MOTOR:

5.1 Each fan shall be driven electric motor direct or through gear reducer. The motor shall be totally enclosed fan cooled (TEFC) weather proof squirrel cage induction motor to the specification as laid down in “Part III B-Specification for electrical motor”. The motors shall be of reputable make.

5.2 Electric motors shall be suitable to operate on A.C. Supply 415 volts 3 phase.

5.3 Motor shall be suitable in all respects for specified fan duty, outdoor moist and general corrosive environment.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 5.4 Suitable canopy covers made of FRP shall be provided for protection of motors against rains. The design of cover shall be such as to provide sufficient ventilation for motors shall have at least cover 100mm clearance all around motor and have adequate exhaust louvers.

6. MATERIAL OF CONSTRUCTION:

MATERIALS AND WORKMANSHIP

All materials used must conform to the applicable standards and codes listed under Section of this specification and must be new and first class in all respect's parts shall be machined true in a workman like manner. Where materials are not specified here in, they shall be properly selected by the Contractor to the best standards followed in the industry for the particular application, subject to the approval of the Purchaser.

All materials shall be tested quality. These shall be free from defects and imperfections. Shall be of certified quality for physical and chemical properties. Materials shall be of IS, ASTM, BS or any equivalent standard. Liberal factor of safety shall be used in selecting thickness of materials.

Sr. No	Description of item	Material of construction	Relevant code or standard
1	Basin	RCC	IS : 456, IS: 3370
2	Casing	FRP	
3	Inlet louvers	Pultruded FRP	
4	Fills	Virgin PVC-UV stabilized with titanium dioxide	C10-19 MM Aqua
5	Fills support	Pultruded FRP	
6	Drift eliminators	Virgin PVC	D31 MM Aqua
7	Spray nozzles	ABS	Dek-Spray Solid rectangle MM Aqua
8	Partition Walls	Pultruded FRP	
9	Structure frame work	Carbon steel Hot dipped galvanized	
9	Covers for Hot water basin and cold-water basin	5 mm thick Aluminum chequered plate	
10	Hard ware	HDGS / Stainless steel 316	ASTM A 193/194
11	Fan cylinder	FRP	
12	Fan blades	Aluminum alloy	
13	Piping (up to 150 NB)	HDG Carbon steel ERW Class C	IS 1239
14	Piping (above 200 NB)	HDG Carbon steel ERW 8 mm thick	IS 3589
15	Flanges ANSI Class 150 rating	HDG Forged carbon steel	ASTM 105 ANSI Class 150

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

7. SPARES AND SPECIAL TOOLS:

7.1 SPARES:

The bidder shall consider following mandatory spares in their offer.

Sr. No.	Name of Component	Qty. recommended
1	Gear box	1 No
2	Fan drive shaft assembly	1 set
3	Coupling rubber bushes	4 sets
3	Fan blade assembly	1 set
4	Fan bearings (gear box)	2 sets
5	Motor bearings	2 sets
6	Set of Oil seals	2 sets
7	Set of 'O' rings	2 sets
8	Spray nozzles (One cell requirement)	One cell requirement

The supplier may also recommend spare parts other than listed above if necessary.

7.2 SPECIAL TOOLS:

The bidder shall supply following Special tools with equipment:

Sr. No	Description	Quantity
1	Vibration meter	One
2	Alignment tool kit (dial indicating type)	One

8. ERECTION, INSTALLATION AND COMMISSIONING

- 8.1. The contractor shall unload, assemble, install, commission, and start up the entire Cooling tower unless otherwise specified; the contractor shall provide all necessary labour, materials, tools, all hoisting equipment and necessary scaffoldings and construction equipment.
- 8.2. Supplier shall be completely responsible for successful erection, installation testing and commissioning of the cooling tower.
- 8.3. The supplier shall give guidance for construction of cold-water basin and foundation for erecting the cooling tower structure.
- 8.4. On completion of the work, the contractor shall remove & dispose off all rubbish and other unsightly materials caused by his working and thereby, leaving the premises and the cooling tower in good, clean, safe & operable condition.
- 8.5. Purchaser or his authorized representative will have the right to inspect at any stage of manufacture and construction, all materials, components and workmanship and testing of material.
- 8.6. The contractor shall provide all facilities for inspection and testing without any extra cost to the owner.
- 8.7. The bidder shall depute at least one competent engineer with proven experience on similar works to supervise the erection of cooling tower and skilled and unskilled labour to ensure completion of works in time.
- 8.8. The contractor shall check the civil works where the plant is to be erected in advance for their correctness/conformity to the approved drawings for erection of the cooling tower

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

with respects to levels, lines, packets, openings cut out etc., and shall notify the purchaser for any major deviation.

- 8.9. All the grout for the equipment shall be carried out using non-shrinkable grout. Surface receiving the grout shall be prepared to receive grout. All block outs for pipes puddle pipes sleeves etc., shall be grouted by using cement concrete of the same grade as that of the parent structure.
- 8.10. The cooling tower shall be erected in accordance with the specific instructions given on the approved drawings, methods and procedures.
- 8.11. The contractor shall follow the safety procedures/regulations/cods or safety instructions from the purchaser and shall take necessary measures at his own cost.

9 QUALITY ASSURANCE, INSPECTION AND TESTING

9.1. GENERAL:

- a) The minimum inspection requirements for all component's equipment shall conform to the specifications and reference codes and standards and approval drawings.
- b) All tests and tests procedure along with the time schedule proposed by manufacturer shall be submitted for Purchaser's approval.
- c) The purchaser will carry out inspection or his representative who should be informed at least 10 days period to vendor's inspection dates.
- d) In case stage inspection vendor is advised to proceed from one stage to another only after component inspection and further clearance to proceed. Similar procedure shall be followed for any rectification/repair suggested by purchaser. The Purchaser shall get the repair procedure in avoidance.
- e) The contractor or his sub-contractor should allow access at all reasonable time during manufacture, assembly. Testing and inspection to the premises where the work is being carried out and shall provide all gauges, instruments, testing facilities required for inspection and testing of component/equipment.
- f) All material used should be new and conforming to specific standards. Test certificates shall be provided for material used composition and physical properties of material used for connecting rod crank shaft, piston rod, piston coolers, motor shaft, cylinders, bearing, balls etc.
- g) For fabricated components all plates, sheets bar stock used shall be tested quality free from lamination and to relevant standards. All welds shall be checked by dye penetrant inspection. Test certificates and mill certificate shall be provided for the material.
- h) For parts of stainless steel or aluminum where magnetic particle test is not possible shall be checked by dye penetrant inspection.

9.2. COOLING TOWER:

9.2.1 SHOP INSPECTION AND TESTING:

- a) The manufacturer shall offer the materials for inspection and testing at their works as per approved drawings and specifications before shipping the materials to site for erection. The purchaser will depute his authorized engineer for witnessing the tests

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

as per approved Q. A. plan. The hot dipped galvanizing procedures shall be got approved by the purchaser.

- b) All rotating parts like shaft, couplings, fan hub and fan blades shall be witnessed for dynamic balancing as per ISO 1940 Gr 6.3.
- c) The gearbox shall be mechanical run tested for 2 hrs and after successful then it is load tested as per the service factor stated in the specifications. The test shall also include to measure the desired speed, vibration, temperature rise etc.,
- d) All the prefabricated components shall be inspected.
- e) The structural components that are hot dipped galvanized will be tested for coating thickness, adhesion test, preece test as the latest standards.
- f) All the materials like fills, inlet louvers, eliminators; splash bars/films shall be checked for relevant standards and approved drawings.

9.3. PIPING:

- a) All welds joints shall be 100% DP tested.
- b) All piping and valves shall be pressure tested by hydrostatic pressure to a pressure of 1.5 times the maximum working pressure.

9.4. ELECTRICAL MOTOR:

- a) The Purchaser's representatives shall witness all routine tests on all motors and heat run on one of the motors as specifications given Part II (F) specification for motors. The test certificates shall be provided.
- b) Should purchaser waive the right to inspect any equipment or even though purchaser carries out inspection. Such inspection shall not however relive vendor of all responsibilities for furnishing equipment conforming to requirements of contract for satisfactory performance after commissioning.

9.5 SITE TESTING: PERFORMANCE & OTHER TESTS:

9.5.1 General:

- a) As soon as the cooling tower has been erected by the supplier as per scope of supply and approved drawings, the supplier shall perform the tests as mentioned below and other test if any to ensure the correctness of cooling tower for the intended design requirement.
- b) Mechanical Run test: Each fan will be mechanical run tested at rated RPM for 72 hrs of endurance test. The parameters like vibration, noise, current and temperature raise for Lube oil of gear reducer and motor temperature and vibration.
- c) Drift losses: The drift losses shall be measured and shall be as per specifications. If not the relevant test reports shall be submitted for verifications.
- d) Air flow measurement: The guaranteed air flow measurement for the required water loading for each cell.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- e) Power consumption: Power consumption will be measured and shall be within the guaranteed limit mentioned specifications and in data sheets.
- f) Vibration: The vibration shall be measured and shall be within the guaranteed limit mentioned in specifications and in data sheets.
- g) Noise: Motors and fans shall operate satisfactory in continuous operation with no injurious vibrations and the sound intensity shall not exceed 85 decibels above threshold level when measured at horizontal distances of 15M from the nearest face of the tower and 1.5M above ground level.

10. PERFORMANCE GUARANTEE:

After successfully commissioning and acceptance of the plant the purchaser all portions thereof will be in accordance with requirement of this contract and will be perfect as to design, materials, workmanship etc. for minimum period of one year from the date of commissioning and acceptance of the plant. Further the supplier shall guarantee that during the guarantee period he will repair defective equipments and work and replace defective materials furnished or installed under this contract free of cost to the purchaser.

10 .1	Cooling tower capacity(Heat rejection per cell)	: 3.78 x 10 ⁶ Kcal/hr
10 .2	Cooling range.	: 4.3 ⁰ C
10 .3	Design cold water temperature.	: 33 ⁰ C
10 .4	Design ambient wet bulb temperature.	: 28.2 ⁰ C (+ 1.7 ⁰ C and -3.9 ⁰ C)
10 .5	Power consumption.	: + 5% of agreed fan HP
10 .6	Drift losses.	: 0.05%
10 .7	Noise level.	: As per specifications
10 .8	Guaranteed Vibration level (Amplitude)	: 0.005"

11. DOCUMENTS, TECHNICAL LITERATURE, DRAWINGS, PERFORMANCE CURVES TO BE SUBMITTED ALONG WITH THE OFFER

Four copes of offer along with following drawings shall be submitted for evaluation as per Part I Clause 5.1 of this tender package.

12. CONTRACTORS DRAWINGS INSTRUCTION AND MAINTENANCE MANUAL TEST REPORTS ETC. AFTER AWARD OF CONTRACT.

Four copes of offer along with following drawings shall be submitted for evaluation as per Part I Clause 5.2 of this tender package.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

13. DOCUMENTS TO BE SUBMITTED AFTER COMMISSIONING OF THE SYSTEM- (4 copies)

Four copes of offer along with following drawings shall be submitted for evaluation as per Part I Clause 6.0 of this tender package

14. CLEANING PROTECTION AND PAINTING

- a. All equipment shall be neatly finished in workman-like manner and all exposed metal surfaces shall be smooth and free from burrs. Finished surfaces shall be protected against corrosion and mechanical damage.
- b. All steel and cast iron surfaces shall be thoroughly cleaned to remove mill scale rust etc. Exterior surfaces shall be given one coat of epoxy primer and minimum two coats of final epoxy paint, paint the color of which shall be approved before hand by purchaser.
- c. After cleaning all interior all openings shall be properly closed with blank flanges caps etc. to prevent entry of water dirt etc.
- d. All parts shall be properly boxed and protected to prevent all possible damage during transpiration.

15. PROTECTION DURING SHIPPING AND STORAGE:

The supplier shall be responsible for ensuring that all equipment's are carefully boxed, crated, or otherwise protected for preventing any possible damage during transportation. All exposed-machined surfaces shall thoroughly grease before dispatch. All nozzles, which have to be welded, shall be made readily for welding and shall be protected by fitting suitable thin metal caps and by welding them tack to nozzles. Tack welds shall not be damaging the nozzles prepared for welding in anyway. All openings with instruments shall be plugged with suitable plastic caps to prevent entry of moisture and dirt.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE I

TECHNICAL DATA SHEET FOR COOLING TOWER (Details to be furnished by the Bidder)

1. GENERAL

- | | | |
|-----|-----------------------|---|
| 1.1 | Manufacture's Name. | : |
| 1.2 | Model No. | : |
| 1.3 | Type. | : |
| 1.4 | No of Cells. | : |
| 1.5 | Operation philosophy. | : |

2. COOLING TOWER DESIGN PERFORMANCE DATA

- | | | |
|------|--|---|
| 2.1 | Total heat rejection (Kcal/hr). | : |
| 2.2 | Heat rejection per cell (Kcal/hr). | : |
| 2.3 | Water flow rate per cell (CMH). | : |
| 2.4 | Design hot water inlet temperature. | : |
| 2.5 | Design cold-water outlet temperature. | : |
| 2.6 | Design entering wet bulb temperature. | : |
| 2.7 | Design ambient wet bulb temperature. | : |
| 2.8 | Design maximum ambient temperature. | : |
| 2.9 | Relative humidity. | : |
| 2.10 | Wind velocity for performance. | : |
| 2.11 | Wind velocity for design of structure. | : |
| 2.12 | Permissible concentration of TDS. | : |
| 2.13 | Required head in hot water header at basin curb level: | : |
| 2.14 | Guaranteed drift loss (%). | : |
| 2.15 | Evaporation (%). | : |
| 2.16 | Blow down loss (%) | : |
| 2.17 | Active tower volume-M ³ . | : |
| 2.18 | Splash Surface-M ² . | : |
| 2.19 | Total wetted surface-M ² . | : |
| 2.20 | Water area/Cell-M ² . | : |
| 2.21 | Air area /Cell-M ² . | : |
| 2.22 | Water flow/M ² of water area. | : |
| 2.23 | Water loading | : |
| 2.24 | Liquid/Gas ratio L/G | : |
| 2.25 | Vibration. | : |
| 2.26 | Noise level. | : |

3. GENERAL DATA:

- | | | |
|-----|----------------|---|
| 3.1 | Total Length-M | : |
|-----|----------------|---|

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 3.2 Total Width :
- 3.3 Operating weight :
- 3.4 Dead weight :
- 3.5 Fan deck height above basin Curb-M :
- 3.6 Fan stack height-M :
- 3.7 Diameter of fan stack at Stack Base-M :
- 3.8 Diameter of fan stack at outlet :
- 3.9 BASIN :
- 3.9.1 Storage Capacity-M3 :
- 3.9.2 Length-M :
- 3.9.3 Width-M :
- 3.9.4 Depth-M :
- 3.9.5 Dimensions of sump :
- 3.9.6 No& Size of EP's (Outlet/Drain/Overflow) :

4. INLET LOUVERS:

- 4.1 Type :
- 4.2 Thickness :

5. FILLS & FILLS SUPPORT:

- 5.1 Type :
- 5.2 Thickness :
- 5.3 Special treatment if any :
- 5.4 Fill volume of one cell-M3 :
- 5.5 Number of lath rows :
- 5.6 Distance between lath rows-mm :
- 5.7 Net dimensions of splash bars-mm :

6. DRIFT ELIMINATORS

- 6.1 Type :
- 6.2 Thickness :
- 6.3 Special treatment if any :

7. FRAME

- 7.1 Type :
- 7.2 Thickness :
- 7.3 Special treatment if any :

8 HOT WATER DISTRIBUTION SYSTEM

- 8.1 Type of Nozzles :
- 8.2 No of nozzles per cell :
- 8.3 Special treatment if any :
- 8.4 Type of distribution valve :
- 8.5 Nos and size of distribution valve per cell :
- 8.6 Nozzle size and pressure rating :

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

9. FAN DETAILS

- 9.1 Fan manufacturer & Model No. :
- 9.2 Number of fans per cell. :
- 9.3 Type. :
- 9.4 Diameter of fans-mm. :
- 9.5 Number of blades. :
- 9.6 Blade angle of incidence. :
- 9.7 Net discharge area-M. :
- 9.8 Hub diameter-M. :
- 9.9 Total differential pressure. :
- 9.10 Drop through louvers-mm. (H2O). :
- 9.11 Drop through eliminators-mm (H2O). :
- 9.12 Velocity pressure-mm (H2O). :
- 9.13 Total efficiency of fan. :
- 9.14 Fan airflow rate/Cell-M3/hr. :
- 9.15 Speed – RPM. :
- 9.16 Fan tip Speed-M/Min. :
- 9.17 Fan B.H.P. :
- 9.18 BHP Of motor. :
- 9.19 Noise level of fan at rated pitch & Speed :
- 9.20 Total power consumption motor inlet-KW :
- 9.21 Fan balancing. :

9.22 GEAR REDUCER

- 9.22.1 Type. :
- 9.22.2 Number. :
- 9.22.3 Model. :
- 9.22.4 Manufacturer. :
- 9.22.5 Reduction Ratio. :
- 9.22.6 Size. :
- 9.22.7 Service factors (AGMA) of gear boxes :
- 9.22.8 AGMA Mechanical HP rating. :
- 9.22.9 Efficiency. :
- 9.22.10 Number of reduction. :
- 9.22.11 Design bearing life. :
- 9.22.12 Design gear life. :
- 9.22.13 Oil Cooling Arrangement. :
- 9.22.14 Lubrication. :

9.23 DRIVE SHAFT

- 9.24.1 Type. :
- 9.24.2 Model. :
- 9.24.3 Manufacturer. :
- 9.24.4 Material of construction. :

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

9.24 COUPLINGS

- 9.24.1 Make. :
- 9.24.2 Type. :
- 9.24.3 Coupling bore (Nominal). :
- 9.24.4 Coupling material. :

10 MATERIAL OF CONSTRUCTION

TYPE /GRADE/STANDARD

- 10 .1 Frame work of members :
- 10 .2 Casing :
- 10 .3 Partitions :
- 10 .4 Filling :
- 10 .5 Grid decks :
- 10 .6 Louvers :
- 10 .7 Fan-Deck :
- 10 .8 Fan stacks (Fan cylinders) :
- 10 .9 Fan Rings for fan Stacks :
- 10 .10 Drift eliminators :
- 10 .11 Joint connectors & Structural connectors :
- 10 .12 Nozzles and splash places :
- 10 .13 Distribution header :
- 10 .14 Risers :
- 10 .15 Flow Control Valves :
- 10 .16 Bolts, Nuts & Washers :
- 10 .17 Anchor Connectors :
- 10 .18 Anchor Bolts :
- 10 .19 Ladder with safety hooks :
- 10 .20 Platforms :
- 10 .21 Stairway & handrail :
- 10 .22 Other hardware & steel fittings :
- 10 .23 Cold water Basin, sump, pits & columns :
- 10 .24 Hot water distribution pipes and pie fittings :
- 10 .25 Screens size and mesh :
- 10 .26 Hot Dipped Galvanized Steel :
- 10.26.1 Coating thickness :
- 10.26.2 Type of process employed :
- 10.26.3 Bath dimensions :
- 10.26.4 Confirming to the relevant standards :

11. STANDARD ACCESSORIES:

11.1 VIBRATION SWITCH

- 11.1.1 Type, make & material specs. :

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

11.1.2 Max. Vibration at which it trips. :

11.1.3 Normal vibration allowed in tower. :

11.2 LOW GEAR OIL LEVEL CUT OFF SWITCH

11.2.1 Type, make & material specs. :

11.3 AUTOMATIC CHEMICAL DOSING SYSTEM:

11.3.1 Type, make & specs :

11.4 SIDE STREAM FILTRATION :

11.4.1 Type, make & specs

12. CALCULATION FOR GUARANTEED POWER CONSUMPTION DATA REQUIRED

Total differential pressure drop-mm. :

Air flow/cell in (m³/min). :

Total fan efficiency (η_1). :

Gear reducer efficiency (η_2). :

Motor efficiency at 100% load (η_3). :

13. PERFORMANCE GUARANTEED:

13.1 Cooling tower capacity :

13.2 Cooling range :

13.3 Design cold water temperature :

13.4 Design ambient wet bulb temperature :

13.5 Power consumption :

13.6 Drift losses :

13.7 Noise level :

14. INSPECTION AND TESTING : Confirm YES/NO

14.1 Dynamic balancing as per ISO 1940 Gr 6.3. :

14.2 The gearbox shall be mechanical run :

14.3 All the prefabricated components shall be inspected including HDG.:

14.4 PIPING:

14.4.1 All welds joints shall be 100% DP tested.

14.4.2 Hydro test.

14.5 ELECTRICAL MOTOR :

14.5.1 The Purchaser's representatives shall witness all routine tests

14.6 PERFORMANCE TESTING & OTHER TESTS:

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <hr/> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

- 14.6.1 Acceptance. Test procedure.
- 14.6.2 **Mechanical Run test:**
- 14.6.3 **Drift losses:**
- 14.6.4 **Power composition:**
- 14.6.5 **Vibration test:**
- 14.6.6 Noise level test:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

PART-II D

CHILLER/CONDENSER WATER PUMPS

1.0 SCOPE

This specification is intended to cover design, manufacture, assembly, inspection, shop testing, packing, supply, arranging transport and delivery of chilled and condenser water pumps complete with all accessories and auxiliaries as specified hereafter to Project INRP-Tarapur.

- 1.1** 5 (Five) Nos of pumps sets in Cast Carbon steel construction for Chilled water pumps, horizontal single stage split volute casing centrifugal pumps along with electrical motors, VFD with each pump, accessories etc. as per specifications.
- 1.2** 5 (Five) Nos of pumps sets in Cast Carbon steel construction for condenser water pumps, horizontal single stage split volute casing centrifugal pumps along with electrical motors, VFD with each pump, accessories etc. as per specifications.
- 1.3** Suitable flexible coupling for above pumps and motor with guards.
- 1.4** Mechanical seal shall be provided.
- 1.5** Base plate with anchor bolts, locknuts etc. for all above pumps.
- 1.6** Pressure Gauges on suction and discharge of all pumps.
- 1.7** Counter flanges for all suction and discharged nozzles with nuts bolts.
- 1.8** Suitable vent and drain connections with valve for all pumps.
- 1.9** One set of unused spares for each type of pumps for 2-years trouble free operation.

2 TERMINATING POINT SCHEDULE

- 2.1 The terminating points covered by this specification the work are as follows:
- 2.2 Pump suction and discharge flanges with counter flanges,gaskets, nuts and bolts.
- 2.3 Vent and drain connections with valves.
- 2.4 Terminal boxes for power cables, space heaters and temperature detectors etc. for motors.
- 2.5 Suction and discharge pressure gauges.

3.0 APPLICABLE STANDARDS

The design, manufacture, assembly and testing of the equipment's covered by the specification shall unless specifically stated otherwise conform to the latest editions of all standards and codes (along with addend mentioned below. In case of conflict between two different classes of specifications the requirements of the more stringent the two shall govern.

- 3.1** Hydraulic Institute Standards, U.S.A.
- 3.2** IS 5120 specifications for horizontal centrifugal pumps.
- 3.3** ISO 5199-2002 Technical specifications for Centrifugal pumps

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 3.4** A.S.M.E. B31.3 codes for pressure piping.
- 3.5** A.N.S.I. B16.5 codes for steel flanges and flanged fittings.
- 3.6** A.S.T.M. standards for various tests and materials.
- 3.7** IS 325 three phase induction motors.
- 3.8** IS 4029guide for testing three phase induction motors.
- 3.9** Instrument Society of American standards.
- 3.10** ISO 1940 Grade for balancing quality.
- 3.11** ISO 10816-1 & 3 1995 Guidelines for Mechanical vibration.

4 GENERAL DESCRIPTION:

These pumps will be used for chilled water and condenser water in chilled water plant. Chilled water loop is closed loop whereas condenser water side is open loop.

5 OPERATING CONDITIONS

6.2.1 Site Condition

- a) Elevation at ground level : Sea Level
- b) Wet bulb temperature : 28.2⁰C(82.76⁰F)
- c) Dry bulb temperature : 35⁰C(93⁰F)

6.2.2 Power Supply

- a) 415 Volts ± 10%, 3-Phase A.C supply
- b) 50Hz ± 5%

6 PERFORMANCE

Consistent with good operating characteristics and high efficiency the pump shall have continuously rising head characteristics from the design point to shut off. The pump shall preferably be of non-overloading type.

Nos	Condition	Chilled water Pump	Condenser water pump
1	Operating fluid	Clear ordinary water	Clear ordinary water
2	Fluid temperature	7 – 12 ⁰ C	30 - 40 ⁰ C
3	Flow	700 CMH	1000 CMH
4	Discharge head (Head Develop by Pump)	60MWC	25 MWC
5	Minimum Efficiency of pump	80%	80%
6	Suction Condition	Flooded suction	Flooded suction
7	Construction	Horizontal split casing double suction	Horizontal split casing double suction
8	Material of construction	Cast Carbon steel	Cast Carbon steel
9	Shaft packing	Stuffing box	Stuffing box

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Nos	Condition	Chilled water Pump	Condenser water pump
10	Shaft Seal	Mechanical seal	Mechanical seal
11	Quantity.	5 nos.	5 nos.

The above-mentioned pump capacities need to be supply by vendor and if capacity of pump increases after final design of chiller plant then supplier shall supply the pump of higher capacity.

7 GENERAL DESIGN REQUIREMENTS:

- 7.1 The pumps shall be single stage, horizontal split volute casing balanced double suction type centrifugal pumps as per performance given at Cl. 6 and generally conforming to IS: 5120 and ISO 5199-2002.
- 7.2 All pumps must be robust in construction with quiet operation. They shall be fitted with renewable wearing parts such as wearing rings, shaft sleeves, etc.
- 7.3 Each pump shall be designed to operate continuously at maximum efficiency with the liquid specified as above. The pump shall preferably be non-overloading type with continuous rising head characteristic from design point to shut off. The operating speed shall be less than 1440 RPM.
- 7.4 The motors shall be complete in all respects shall be as per specification attached here with vide Part II F. The motor selected shall be to suit the pump's operation requirement as per Annexure- A. The motor input KW shall be at 120% of the designed capacity (rated) or to suit the requirement of pump at the design point with 15% margin whichever is higher.
- 7.5 The impeller and rotating assembly shall be statically and dynamically balanced to grade 2.5 as per ISO: 1940 and checked for eccentricity.
- 7.6 The impeller selected shall be at least 5% smaller in diameter than the maximum size that can be incorporated in the casing.
- 7.7 The pumps and the motors shall be free from undue vibration and shall be capable of withstanding stresses which may be experienced during startup, normal operation, and tests. Unfiltered vibration shall not exceed the vibration severity limits given in Table 1 of ISO 5199 or ISO 10816-3 whichever is the stringent.
- 7.8 Anchor bolts, nuts, locknuts, base plate, etc. as required shall supplied with the equipment. Only hexagonal nuts shall used. All bolts holes shall be spot faced for nuts.
- 7.9 The equipment shall be designed to permit interchangeable of parts and ease of access during inspection, maintenance and repair.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 7.10 The first critical speed of the rotating assembly shall be at least 30% above the operating speed. The running speed shall be less than the first critical speed.
- 7.11 All parts subject to substantial temperature changes shall be designed and supported to permit free expansion and contraction without resulting in leakage, excessive dispassion or misalignment.
- 7.12 All pressure containing components including the pump casing, nozzles and stuffing box housing shall be designed, fabricated and tested as per ASME Boiler and pressure vessel code Section-VIII.
- 7.13 The casing joints shall be provided with dowels for accurate reassemble after opening.
- 7.14 Pipe weld ends shall be to ANSI unless specified otherwise.
- 7.15 All materials used shall conform to the specification and shall be new and first class in all respects.
- 7.16 All casting and forging shall conform to their respective materials specification and shall be free from flaws and objectionable imperfections, machined true and in workman like manner.
- 7.17 Suitable lifting arrangement such as eyebolts etc. shall be provided to pumps and accessories for ease of handling.
- 7.18 Proposal for repair or similar operation involving the plugging, welding, boring or addition of metal to the original casting or forging shall be submitted to the Purchaser and his approval shall be received before such work is carried out. Drawing showing details and location of such modification shall be submitted to the Purchaser for his records.
- 7.19 Each pump shall be provided with pressure gauges on suction and discharge. The pressure gauges should be of suitable range with dial not less than 100mm dia. And readability up to 0.20MWC with accuracy +1% of scale span at any point on the scale. This accuracy shall be established at least five different pressure points. The bourdon tube shall of Phosphor Bronze and must with stand an overpressure of at least 150% of full-scale pressure. The readability of scale shall be not more than 0.20MWC.
- 7.20 **COUPLING:**
 The pump shall be directly coupled with the electric motor through suitable flexible type coupling to take care of usual shaft misalignment, shaft expansion and ease of dismantling during maintenance of pumps, Couplings should be guarded. The coupling shall be statically and dynamically balanced.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

7.21 All bought out items shall be subjected to tests and approval of the purchaser. The bought-out items should be approved and/or best available make.

8 GENERAL PUMP CONSTRUCTION:

8.1 The pumps shall be of horizontal shaft with impeller arrangement for best radial balance, minimum thrust loads and for least possible distortion of internal parts from sudden changes in capacity or temperature.

8.2 Material of Construction

The following materials shall be used for the construction of various parts of the pumps:

Nos.	Parts	:	Pumps
1	Casing	:	Cast steel to ASTM-A216gr. WCB
2	Impellers	:	Bronze as per ASTM-B-143
3	Shaft	:	EN-8 or Carbon Steel type 4140
4	Shaft sleeves wearing rings	:	Bronze
5	Fasteners	:	All fastener of Carbon Steel
6	Base plate	:	MS fabricated
7	Counter Flange	:	Carbon Steel

8.3 CASING:

The casing shall be so proportioned that the velocity of liquid be gradually reduced and converted to pressure with minimum friction and wear. The surface finish should be smooth. The pump shall be so designed that the differential pressure across the sealing surface and stuffing boxes is minimum. The design pressure of the pump shall not be less than the suction pressure plus shut off the pump. The casing should have proper venting and draining provision with valves. It should be rigid and properly supported to resist misalignment and distortion from pipe loads. The waterways should be coated with special coating with “corrocoat” to improve the surface finish for higher efficiency.

8.4 IMPELLER:

The impeller rotating assembly shall be statically and dynamically balanced to grade 2.5 as per ISO: 1940 and checked for eccentricity. All waterways shall be smooth finished. The impeller selected shall be at least 5% smaller in diameter than the maximum size that can be incorporated in the casing.

8.5 SHAFT SLEEVES & WEARING RINGS:

Shaft sleeves and wearing rings shall be replaced and with high surface hardness. Shaft sleeves shall be positively driven, clamped and sealed at impeller end but it should be free to expand at other end. The critical surface of shaft sleeve should be properly secured 0.8 micron. The wearing ring should properly secure to prevent turning. Impeller wearing ring hardness shall preferably be greater than casing wearing ring hardness.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

8.6 STUFFING BOX:

Packed type stuffing boxes of adequate depth and good inside surface finish shall be provided for minimum leakage and ease of maintenance.

8.7 BEARINGS:

Inboard radial bearing shall be of floating type in axial direction in the frame. Outboard bearing shall be adequately designed to take all the thrust for either direction of rotation of pumps under all emergency conditions including reverse rotation runaway speed. Out board bearings shall be locked and located on shaft. All bearings used shall be of precision and reputed make.

8.8 COUPLINGS:

The pump shall be directly coupled to motor through suitable flexible/spacer type coupling to take care of usual shaft misalignments, shaft expansion and ease of dismantling during maintenance of pumps. Couplings should be properly guarded. The couplings shall be statically and dynamically balanced.

8.9 BASE PLATES

Common C.I. or MS/SS Fabricated base plate shall be provided for motor and pump. The base plate should be rigid with provision of drain lips and necessary draining connections. The base plate should be properly drilled for suitable anchor bolts and holes shall be spot faced for nuts.

8.10 NOZZLES:

Pump suction and discharged nozzles shall be provided with flanged connections drilled to ANSI B 16.5, 150Lbs. Class. All flanged should be provided with counter flanges as per Type I & II construction and nuts and bolts. The counter flanges shall be forged to ASTM-A-105, SORF.

8.11 LOCAL INSTRUMENTATION:

Pressure gauges shall be provided for all the pumps on suction and discharge. There must conform to the specification as stated in this specification.

8.12 MECHANICAL SEAL:

All pumps shall be fitted with mechanical seal. The mechanical seal shall be single, internal, unbalance cartridge seals types with dry running capability. The mating surface shall be preferably solid silicon carbide with solid silicon carbide.

9 DRIVE MOTORS

The motors driving the pumps shall be designed to suit the operating conditions as described earlier in this specification. The motors shall be complete in all respects as per the motor specification attached herewith vide Part-II-F, Technical specification for motors.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

10 SPARE PARTS

The supplier for each type of pumps and drives shall consider following mandatory spare parts in their offer. The supplier may also recommend spare parts other than listed below if necessary.

Nos.	Spare & Parts	Nos. of set
1	Shaft & Sleeves	One Set for each type
2	Bearings	Two sets for each type (Pump & Drive)
3	Wear rings	One set for each type
4	Stuffing box packing	One set for each type
5	Mechanical seal assembly	One set for each type
6	Gaskets	One set for each type
7	Complete rotating assembly Of each type	One set

11. INSPECTION & TESTING REQUIREMENT

11.1 GENERAL:

- 11.1.1 The minimum inspection requirement for all components/equipment shall conform to the specification and reference codes standard and approved drawings.
- 11.1.2 All tests and test procedure along with the item schedule proposed by the manufacture shall be submitted for purchase approval.
- 11.1.3 The purchaser will carry out inspection or his representative who should be informed at least 10 days prior to vendor schedule inspection dates.
- 11.1.4 The contractor or his subcontractor should allow access at all reasonable time during manufacture, assembly, testing and inspection to the premises where work is being carried out and shall provide all gauges, instruments, testing facilities required for inspection and testing of components/equipment.
- 11.1.5 All material used for manufacture of the equipment should be new and conforming to specific standards and of tested quality. Relevant mill test certificates shall be made available to the purchaser before the final shop inspection.
- 11.1.6 Unless otherwise stated inspection/test shall be conducted in the presence of purchaser and/or his representative. The purchaser shall at his option waive the requirement of his engineer's presence during any or all of the stage inspection.

11.2 INSPECTION & TESTING AT MANUFACTURER'S WORKS

- 11.2.1 Casting shall conform to relevant specifications. Casting shall have a test bar from which tension tests specimen shall be taken. The specimen shall be tested as per ASTM A-370 and copies of ladle analysis and physical test on specimen shall be submitted to purchaser.
- 11.2.2 Casting shall be sound, clean and free from porosity blowholes, hard spots, cold shuts, distortion and other harmful defects. All casting shall be examined by liquid dye penetrate inspection in accordance with ASTM -E-165. Inspection shall be carried out

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

after rough machining operation. Any indication that is not removed during finial machining shall be gouged out and repair shall be carried out unless approved by the purchaser.

11.2.3 All shafts shall be ultrasonically tested and shall meet the material requirements of relevant ASTM or IS specification and relevant test certificate shall be provided.

11.2.4 Pump casing shall be hydrostatically tested in the shop to a pressure of one and a half times the respective maximum discharge pressure or twice the operating pressure whichever is higher relevant to design fluid minimum thickness shall be checked as per data. All pump shall be tested for mechanical running to check the soundness and vibration limits with in specified limits.

11.2.5 PUMP PERFORMANCE TEST:

- a) Performance test shall be conducted for each of the pumps in accordance with IS: 5120 to demonstrate the specific performance requirement. Tendered shall submit with his bid the details of the facility available with him along with the procedure for test. The purchaser or his representative shall witness the tests. The test procedure shall be subject to Purchaser's approval.
- b) All pumps shall be tested for plotting the characteristic curves i.e. capacity against head, power and efficiency. At least five readings shall be taken. These shall include shut off, design flow and 120% of the design flow. The readings should be equally spaced. Designed fluid requirements shall be met while testing.

12. PERFORMANCE GUARANTEE

Each equipment shall be guaranteed to meet the performance requirements of this specification for design fluid. The tests shall be conducted at manufacture's works as given above. If the equipment fails to meet the guarantee in any respect for any reason whatever and it is necessary for the supplier to make alterations for the purpose of meeting the guarantee. The alterations shall be made and additional tests required showing the effects of such alterations shall be performed by the supplier at no expense to the purchaser.

12.1 Allowable tolerances on capacity of pumps:

- (-) Zero
- (+) 10%

12.2 Allowable tolerances on pump head:

- (+) 3.0%
- (-) Zero

12.3 Allowable tolerance on power consumption for pumps:

- (+) 2.5%
- (-) Anything

12.4 VIBRATION

Amplitude of vibration at bearing of rotating equipment shall conform to ISO:10816-3 or ISO 5199.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

13. TECHNICAL LITERATURE, DATA SHEETS AND PERFORMANCE CURVES AND DRAWINGS TO BE SUBMITTED ALONG WITH THE OFFER AS GIVEN BELOW.

- 13.1 Four copies of the following supporting documents shall be submitted for detail evaluation of the bid with quotation for each type of pump:
- a) General arrangement drawing of pumps and motor with coupling arrangement for all types.
 - b) Sectional assembly drawing of pumps showing part list and material of construction.
 - c) Characteristic curves of pumps showing capacity against head, power efficiency and NPSH pump for design fluid
 - d) Component drawings [detail of stuffing box with normal packing arrangement and mechanical seal.
 - e) Description of shop inspection testing and quality control facilities and quality assurance plan proposed.
 - f) Speed Vs Torque, Speed Vs Load characteristics and Starting current Vs Time characteristic for motors.
 - g) Complete description, illustrated literature/catalogue of equipment offered in specific (pumps/mechanical seal)
 - h) Foundation detail drawings for all types of pumps.
 - i) Dimensional drawings of the motor showing terminal boxes and method of termination of purchaser's cables.

13.2 DATA TO BE FURNISHED ALONG WITH THE OFFER

As per Part-I clause no.5 & 6.

14. AFTER AWARD OF CONTRACT OR PURCHAE ORDER:

- 14.1 Supplier before commencing with shop fabrication and within 30 days from receipt of order shall prepared and submit to purchaser for approval four(4) sets of his quality assurance and plans giving detail time schedule preferably in the from of PERT/CPM net work covering various phases e.g. Preparation of shop drawing, procurement of material, manufactures, assembly, inspection, testing, delivery to site, etc.
- 14.2 Within three (3) weeks from the date of receipt of order the supplier shall submit four (4) copies of list of drawings. The proposes to submit for approval before commencing with shop manufacture. These drawings shall include general arrangement drawings of pumps coupled to motor giving dimensions, nozzle details, etc. cross sectional assembly drawing of pumps giving fabrication details component details and bill of materials with material of construction etc., foundation drawing giving loading data and grouting details,etc. motor dimensional drawing showing the terminal boxes and

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

method of purchasers cable termination etc. these drawings when approved in writing by the purchasers shall form part of this specification. No work on manufacture shall commence unless the purchaser approves the drawings in writing. Any prior approval work done shall be at contractor's risk. warranty

- 14.3 Supplier shall furnished one (1) reproducible and five (5) additional complete sets of final drawings including all subsequent revisions approved by the purchaser. The reproducible shall be of good quality capable of producing clear legible prints.
- 14.4 Supplier shall submit copies of design calculations including hydraulic design and pressure part calculations. The vendor shall satisfy the purchaser as to validity of his design to specification requirements.
- 14.5 Supplier shall submit five (5) copies of all relevant material tests reports, manufacture's tests certificate, hydrostatic tests certificate performance tests certificate etc. as asked in the specification and testing.
- 14.6 Supplier shall submit five (5) numbers of bound copies of instructional manuals for each type of pump for installation operation and he furnishes maintenance of the equipment. The manuals for each type of pump for installation operation and maintenance of the equipment furnished by him. The manuals should include drawings and performance curves, assembly and disassembly procedure, parts replacement, etc. the manual shall be got approved by the purchaser before full supply is made.
- 15. CLEANING PROTECTION AND PAINTING**
- 15.1 All equipment shall be neatly finished in workmen like manner, all exposed metal surface shall be smooth and free from burrs. Finished surface shall be protected against corrosion and mechanical damage.
- 15.2 All steel and casting surfaces shall be thoroughly cleaned to remove mill scale, rust, etc. exterior surface shall be given one coat of epoxy primer and minimum two coats of final epoxy paint, the colour of which shall be approved before hand by the purchaser.
- 15.3 After cleaning all interiors, all openings shall be properly closed with blank flanges caps etc. to prevent entry of water, dirt etc.
- 15.4 All parts shall be properly boxed and protected to prevent all possible damage during transportation.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE-I

TECHNICAL PARTICULARS FOR THE PUMPS SHALL BE SUBMITTED ALONG WITH
THE OFFER

Sl. No	Particulars	:	Chilled water Pump	Condenser water Pump
1	Make & Model No	:		
2	Capacity (m ³ /hr)	:		
3	Total discharge head (MWC)	:		
4	Suction head (MWC)	:		
5	Shut off head (MWC)	:		
6	Fluid temperature	:		
7	Fluid density	:		
8	NPSH required (MWC)	:		
9	Minimum re-circulation flow	:		
10	Pump shaft input (KW) required at	:		
10.1	80% design capacity	:		
10.2	100% design capacity	:		
10.3	120% of design capacity	:		
11	Pump efficiency excluding at 80%, 100% and 120%	:		
12	Motor BKW (KW)	:		
13	Pump set overall efficiency @ 80% 100% and 120%	:		
14	Pump speed (RPM)	:		
15	Impeller diameter selected (mm)	:		
16	Maximum Impeller diameter can be used in casing (mm)	:		
17	Minimum casing thick. (mm)	:		
18	Maximum working pressure (Kg/Cm ² g)	:		
19	Hydrostatic test pressure in (Kg/Cm ² g)	:		
20	Direction of rotation viewed from pump end	:		
21	Impeller radial clearance in mm ϕ	:		
22	Shaft dia. at impeller mm ϕ	:		
23	Clearances at impeller wear rings mm ϕ	:		
24	Shaft dia. at stuffing box mm ϕ	:		
25	Static deflection of shaft at impeller wearing rings mm	:		
26	Method of inertia fastening impeller to shaft	:		
27	Moment of inertia of rotating assembly	:		
28	Sleeve surface finish micron	:		
29	Nozzle size & ratings (suction & discharge)	:		
30	Bearings	:		
30.1	DE/NDE bearing Nos, Qty& Make	:		
30.2	Design life at normal operating condition	:		

SPEC. NO.:
NRB/128-
CHW/INRP/2020

**NUCLEAR RECYCLE BOARD
BHABHA ATOMIC RESEARC CENTRE**

**TECHNICAL SPECIFICATIONS FOR CHILLED
WATER PLANT**

PROJECT:
CHILLED WATER
PLANT (UTILITY
BLOCK-2) AT INRP
TARAPUR

Sl. No	Particulars	:	Chilled water Pump	Condenser water Pump
31	Coupling	:		
31.1	Type, Make & Model	:		
32	Stuffing Box	:		
32.1	Bore & Depth (mm ϕ x mm)	:		
32.2	Packing arrangement	:		
32.3	Surface finish micron	:		
33	Mechanical seal	:		
33.1	Type, Make & Model	:		
33.2	Seal arrangement & Plan	:		
33.3	Surface finish micron	:		
34	Material of construction	:		
34.1	Casing	:		
34.2	Impellers	:		
34.3	Shaft	:		
34.4	Shaft sleeves	:		
34.5	Casing & wearing rings	:		
34.6	Mechanical seal	:		
34.7	Glands	:		
34.8	Fasteners	:		
34.9	Base plate	:		
34.10	Counter flanges	:		
35	Provision of accessories	:		
35.1	Foundation bolts	:		
35.2	Counter flanges	:		
35.3	Pressure gauges Make/Range/Dial size/Connection	:		
35.4	Vent and drain cocks	:		
36	Impeller balancing grade	:		
37	Maximum vibration (Displacement/Velocity) peak to peak or RMS	:		
38	Maximum noise at 1 mtrs from center of pumps	:		
39	General	:		
39.1	Complete pump and drive assembly weight in Kg	:		
39.2	Rotating assembly weight in Kg	:		
39.3	Motor weight in Kg	:		
39.4	Overall dimensions	:		
40	Confirmation to Inspection and testing as per TTS	:		
41	Submission of documents as per TTS	:		

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <hr/> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

PART-II - E

CONDENSER AND CHILLED WATER PIPING

SPECIFICATION-TECHNICAL REQUIREMENTS

1. SCOPE

This specification covers the technical requirements and essential particulars for the supply, shop fabrication, inspection, erection, testing and cleaning of the piping for condenser water and chilled water piping for (1000×5) TR. Centrifugal chilled water plant for Project INRP, Tarapur as covered in the specification documents and drawings. The Contractor shall demonstrate that the piping satisfies the requirements of the specification and applicable codes.

2. APPLICABLE CODES, STANDARDS AND DRAWINGS:

2.1 All piping system shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. The piping shall also conform to the latest editions of the codes and standards listed below and other applicable standards. Nothing in this specification shall constructed to relieve the Contractor of this responsibility.

2.2 The Equipment and work under this contract conform to the following standards/codes.

- i) ASME Boiler and Pressure Vessel Code, Section II, and VIII Div. 1 .
- ii) IS 2062 for M.S. plate Structural steel quality
- iii) IS 808 for Rolled structural steel channel/ angle/flats
- iv) IS 1239/ASTM-A53/ASTM-A106 for M.S. black seamless/ welded pipes
- v) IS 3589/ASTM-A358 for M.S. welded pipes
- vi) IS 814 Specification for covered electrode for metal arc welding
- vii) AWS A5.1 Specification for Mild steel covered arc welding electrodes
- viii) IS 102 Ready mixed paint, brushing, red lead non-setting priming
- ix) IS 816 Code of practice for use of metal arc welding for general construction
- x) IS 823 Code of practice for Manual metal arc welding of Mild steel
- xi) ANSI B 31.3 ANSI code for chemical plant and petroleum & refinery piping
- xii) ASME Section IX qualification of welders and welding procedures
- xiii) ASTM E 165 Liquid penetrant inspection
- xiv) BS 5155 Specification for butterfly valves
- xv) ASTM-A-193 specification for alloy steel bolts
- xvi) ASTM-A-194 specification for alloy steel nuts

In case of conflict between codes and standards referred to herein and the requirements of this specification, the matter shall be brought to the attention of the 'Engineers' for resolution.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3 APPLICABLE DRAWINGS:

1. DRG No: A1/IP1/07.01.00/002/FS/R0 – Schematic Flow sheet for chilled water system.
2. DRG No: A1/IP1/07.01.00/003/PL/R0 – General arrangement for chilled water Plant.

3. CONTRACTOR'S SCOPE OF WORK

3.1 Scope of design:

3.1.1 PIPING Layout:

- a) The contractor shall develop an equipment layout drawing, P&ID based on purchaser inputs and generate piping layout drawing along with supports and get approval of the Purchaser.
- b) Following guidelines, but not limited to, shall be considered for finalizing of the piping layout:
 - i. Head room
 - ii. Interference with other piping, equipment, structures, cable trays, ducting etc.
 - iii. Large diameter piping shall be laid first. Small bore piping (40 NB and below) shall be routed after the large pipe as per the space availability.
 - iv. The layout shall follow good engineering/ industrial practices so as to optimize the material requirement.
 - v. The layout shall have change in directions to impart adequate flexibility wherever required.
 - vi. All piping shall be supported from the floor. The piping layout shall facilitate adequate support to pipe, fittings and components to avoid excessive stresses, deflections.
 - vii. Layout shall not restrict the space for man & material movements. Pipes shall not be routed in operating area of crane, monorail, other material handling equipment and designated maintenance space.
 - viii. Sufficient clearance around equipment, pumps etc. shall be provided for man, material movement and maintenance activities.
 - ix. Sufficient gap between two pipe shall be provided to facilitate welding of pipes during fabrication/ maintenance and to accommodate, / operate, remove valves, tightening of bolts of flanges etc.
 - x. Manually operated valves shall be installed at convenient height for ease of operation and maintenance.
 - xi. All instruments, display panels, gauges etc. shall be provided at convenient height and locations for observations, operations/ maintenance.

3.1.2 PIPING DESIGN:

- a) Piping and support design shall be as per ASME B31.3, IS-800 and prevailing good engineering/ industrial practices.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- b) The minimum requirement of pipe thickness for above ground piping as below:
 Pipe size up to 40 NB (including) :Sch 40
 Pipe size more than 40 NB :Sch 10
- c) Span between two vertical supports shall be as per table-1 (MSS SP-69).
- d) Apart from the above span, support shall be provided near concentrated weights like, valves etc.
- e) Support scheme shall provide adequate lateral & axial stiffness to the piping without compromising the flexibility.
- f) U-clamps/ bolts shall be provided on straight runs to restrict lateral movement of pipe.
- g) Appropriate pipe supports (rest, guide, anchors, limit stops) shall be used to control pipe stresses & deflections and loads on the terminal equipment.
- h) Civil related structures like foundation, plinth beam and Pedestal for supports of equipment and piping shall be designed as per purchaser approved design procedures. Construction of civil structure, pedestal and foundation will be taken care by purchaser based on approved detailed construction drawing released by supplier
- i) Pipe support structure shall be rolled sections as per IS-808 and designed as per IS-800.
- j) Apart from weight of the pipes along with fittings, content, frictional load (30% of weight) in axial direction and a lateral load of 20% of piping weight shall also be considered for support design.
- k) A calculation sheet for support qualification shall be submitted for Purchaser's approval.

3.1.3 PIPE SUPPORTS

- a) All equipment & piping in chiller plants to be supported from floor.
- b) Contractor shall install pipe supports shall be installed in accordance with the approved layout & design worked out by the contractor. During erection, piping shall be provided with adequate temporary supports until the final supports are installed. Temporary supports shall rest on paving or in direct or indirect contact with concrete or structural beams. Platform grating or scaffolding shall not be used for temporary supports. The CONTRACTOR shall supply the necessary materials including the anchorages for the temporary supports as a part of his scope of work and remove the same after completion of site work.
- c) Permanent pipe supports shall be welded to the EPs (embedded plates) on the floor for the same. In absence of the EPs, contractor shall provide base plate with HILTI anchor fasteners or equivalent, size and type approved by the Purchaser, on the floor.

3.2 Scope of Supply

- 3.2.1 The scope of work of the bidder under this tender is as defined in this specification. For all piping system included in his scope of work, Contractor shall supply all materials as required in order to render the piping system complete, Contractor's scope of supply shall include but not be limited to:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- a) Complete assemblies of hanger supports, anchors, guides, restraints etc., including welded attachments, clamps, clevises, rods turn buckles, U – clamps, clips, shoes, rollers, trapezes etc.
- b) Auxiliary steel for hangers, supports, guides, restraints, anchors etc.
- 3.2.2 Contractor shall provide all necessary drains and vents as required for the safe effective draining/venting of the piping system.
- 3.2.3 Contractor shall supply necessary auxiliary steel and other supporting materials such as steels, saddles, base plates, clamps, U-bolts, angles, clips etc.

3.3 Scope of Erection

- 3.3.1 All the system supplied by the Contractor shall be erected by the Contractor.
- 3.3.2 All valves, strainers, separators, traps, thermo wells flow nozzles, orifices, orifices plate assemblies, flow meters, sight flow indicators and other in-line specialties supplied by others but which from a part of the piping system erected by the Contractor shall be installed by the Contractor to render the systems complete within his terminal points.
- 3.3.3 Fabrication and erection of pipe supports including shoes, guides, shops/anchors, clips, cradles, hangers, turn buckles, supporting fixtures, brackets, cantilever struts, etc.

3.4 Scope Of Supply For Erection & Testing:

- Bidder's scope of supply for fabrication, erection, cleaning, testing and commissioning of the piping system installed by him shall include the following:
- 3.4.1 All welding consumables like welding electrodes filter rods and wires, gases like Oxygen, Acetylene, Argon, Carbon dioxide, Pane etc.
 - 3.4.2 Dye penetrant and other required non-destructive testing materials and equipment.
 - 3.4.3 All machinery, crane, equipment tools and tackles as required for transportation, handling, fabrication and erection.
 - 3.4.4 All scaffolding materials and false work.
 - 3.4.5 All thread sealing tapes as identified for each pipe grade.

4. DESIGN REQUIREMENTS

4.1 PIPE, PIPE FITTINGS AND VALVES.

- 4.1.1 The maximum working pressure in the chilled water and condenser water piping is 10 Kg/cm². Hence the pipe and all piping components like bends, reducers, flanges shall be Class 150 rating
- 4.1.2 All gate/globe valves up 50 mm NB shall be bronze valves with flanged ends with class 150 rating.
- 4.1.3 The isolation valves on pump and chilled water plant of size 150mm NB and above shall be butterfly valves with class 150 rating. The valves with 200 mm NB and above shall be gear operated.
- 4.1.4 The strainer shall be POT type strainers or Y type strainer with element shall be stainless steel with 60 mesh suitably supported on SS perforated plate. Condenser water pump suction shall have automatic self-cleaning strainer for cooling water.
- 4.1.5 The Non-return valves of the pump discharge shall be Wafer type dual plate check valves.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4.1.6 Isolation valves of equipment's etc. shall be of pneumatic actuated type with manual override and throttling valves shall be of motorized type with manual override for better control of system. These shall be equipped with on/off limit switches for taking feedback.

4.2 THERMAL INSULATION:

The chilled water piping shall have the thermal insulation (selection, thickness etc.) as per design carried out by supplier based on last distribution point of chilled water supply along with other design parameters. The thermal insulation shall be carried out after successful erection and testing of chilled water line or alternatively, pre-insulated pipes are preferable. Material will be procured after approval from the user. Supplier can suggest pre-insulated pipes with outside cladding and better insulation material with good fire resistant, low temperature drop and less maintenance point of view for approval to purchaser.

The insulating materials expanded polystyrene type SE (self-extinguishing) shall conform to BIS-4671 latest standards and thermal conductivity value shall be as per BIS-3346. Slabs and pipe sections shall have a minimum density of 15 kg/m³ and where pipe supports are outside the insulation on 40 mm nominal or larger diameter pipe polystyrene pipe sections are 25 kg/m³ minimum density shall be used. The thickness of insulation shall be specified by the bidder with necessary design calculations and should not be less than 50mm thick for pipes up to 150mm NB and 75mm thick for pipes ranging from 150mm to 300 mm NB size.

Industrial bitumen grade 85/25 conforming to BIS-702 shall be used as vapor barrier. For removable type of insulation, jacketing material on equipment, valves and flanges shall be at least 0.091mm (0.036") thick aluminum sheet. For non-removable type of cold insulation thermal-insulating cement mixed with per portions of water proofing cement and sand shall be used as jacketing materials. Other material shall be as follows:

- Lacing wires GI & washers : Soft annealed 0.884 dia. Minimum
- Chicken wire netting : 12.5 mm X .71 mm hexagonal galvanized
- Steel bands : 12 mm wide X 0.6 mm thick.

The insulation applying procedure will be the best workman ship like manner and thickness of insulation approximate to the temperature range. Necessary testing certificates should be furnished for the quality of insulation. All joints and seams shall be carefully sealed to form a vapor barrier. Any other make subject to evaluation and approval by the department. Closed rubber cell insulation of chiller shall not be painted. The procedure and insulation shall got be approved by the purchaser.

4.3 FABRICATION:

4.3.1 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cables trays, structural member, equipment etc. The above to accommodate insulation and pipe movements.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 4.3.2 Studs for instrumentation, drains, vents, etc. wherever not located on Owner's piping layout drawings shall be suitably located by Contractor in accordance with the flow diagrams and layouts/isometrics.
- 4.3.3 The design, layout and supporting of all temporary pipe work as required for erection, cleaning, flushing, blowing out, testing and commissioning of the piping system installed by the Contractor is the responsibility of the Contractor.
- 4.3.4 Plan and section drawings, in general are made to scale However the Contractor shall not scale any drawings to ascertain dimensions. The Contractor shall use dimensions and grades relevant to site.

4.4 HANGER AND SUPPORTS

- 4.4.1 The materials used in construction of hangers, supports and accessories shall be the most suitable for the service intended. Contractor shall apply one coat of red oxide zinc chromite.
- 4.4.2 Lugs or other means of welded attachment to pipes shall be welded on in the shop and shall be of the same materials as the parent pipes.
- 4.4.3 All supports for piping shall be provided with carbon steel machine bolts, nuts in accordance with applicable codes. Bolts heads shall be regular square and unfinished. Nuts shall be cold punched, semi-finished, heavy hexagonal type.
- 4.4.4 All anchors shall be designed for rigid fastening to the structures either directly or through a bracket. Anchors and guides shall be capable of withstanding the moments and forces imposed by thermal expansion.

5. MATERIALS SPECIFICATION:

- 5.1** All materials supplied by the Contractor shall be new and unused.
- 5.2** Per materials test certificates shall certify all materials. All materials test certificates shall carry per heat number or other acceptable references to enable indication of the certificate with the materials it purports to certify. The heat numbered shall also be indicated on the material.
- 5.3** Specification for various materials shall be as given below.

Sl.No	Item	Material of Construction	Relevant Standard
1.	Condenser water piping	MS Black ERW pipe Heavy (Class 'C' pipe) up to 150mm NB dia and minimum 7mm Thick pipe for 200mm NB and above.	IS1239& IS3589/ ASTM A53
2	Chilled water piping	MS Black ERW pipe Heavy(Class 'C') pipe up to 150mm NB dia and minimum 7mm Thick pipe for 200mm NB and above	IS 1239 & IS3589/ ASTM A53
3	Pipe fittings like bends reducers, for piping	Carbon steel forged Butt welded class 150 rating	ASTM A 234 & dimensions as per ANSI B 16.9
4	Flanges	Forged carbon steel flanges Class 150	ASTM A 105 &

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Sl.No	Item	Material of Construction	Relevant Standard
		rating with SORF	dimensions as per ANSI B 16.5
5	Bolts/Nuts& Washers	Carbon steel	As per ASTM A193 Gr B7 and A194 Gr 2H
6	Manual or pneumatic actuated Valves(with manual override) upto 50mm NB size as per design requirement	Bronze gate/globe valves with flanged ends Class 2 and pressure rating 1.6 Mpa	As per IS 778
7	Manual or pneumatic actuated(with manual override) Valves 50mm above (Butterfly valves) as per design requirement	Wafer type butterfly valves with pressure rating Class 150. Body Cast Steel Disc Stainless steel Seat Stem and internals	As per BS 5155 ASTMA 216 WCB ASTMA351 CF8M Resilient PTFE/ Stainless steel
8	Non-return valves	Wafer type dual plate check valve with pressure rating Class 150 Body Cast Steel Disc Stainless steel Seat Stem and internals	ASTMA 216 WCB ASTMA351 CF8M Resilient PTFE/ Stainless steel
9.	Control valve for primary variable flow with electrical actuator and manual override	Bronze gate/globe valves with flanged ends Class 2 and pressure rating 1.6 Mpa	As per relevant code
10.	Thermal Insulation for Chilled water piping	Expanded polystyrene and as per specification given at 5.2	As per IS 4671
11.	Automatic self-cleaning strainer	Automatic self-cleaning provision for condenser water pump suction header with wedge-shaped stainless-steel wire type screen Body Cast steel Cover Cast steel Screen Plug	ASTMA 216 WCB ASTMA 216 WCB Stainless steel ASTMA105
12	Pot/Y type type strainer	Wedge-shaped stainless-steel wire type screen Body Cast steel Cover Cast steel Screen Plug	ASTMA 216 WCB ASTMA 216 WCB Stainless steel ASTMA105

6. FABRICATION, WELDING AND ERECTION.

6.1 FABRICATION:

- 6.1.1 Contractor shall prepare necessary fabrication drawings based on Owner's layout drawings for these systems. Contractor's fabrication drawings shall take into account the requirement of the specification as also applicable codes and standards. Fabrication and erection of pipe system shall be as per Contractor's fabrication drawings and Owner's layout drawings/isometrics.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 6.1.2 All welded attachment on pipeline shall be of the same materials as the parent pipeline and shall be subjected to the same fabrication and welding procedures as the parent piping.
- 6.1.3 Where welded pipe or fitting are used, longitudinal welds in adjoining section shall be staggered to a minimum of 90⁰ during fabrication.
- 6.1.4 All piping fabrication true to lines and elevation as indicating in the piping drawings/isometrics.
- 6.1.5 All pipes bend shall have a radius specified on the Owner's piping drawings/specification. The pipe bends shall be true to angle and radius and shall maintain a true circular cross-section of pipe without deformity or undue stretching. Crimping of pipes to form bends is not acceptable.
- 6.1.6 All pipe flanges and contact surfaces shall be concentric with the axis of the piping. All flanges and flanged fittings shall be accurately machined and drilled true to the template. Flange bolt holes shall straddle the normal centerlines unless different orientation is shown on drawings to match equipment connections etc.
- 6.1.7 All welded branch connections shall be of suitable structural adequacy by virtue of the intrinsic weld connection, reinforcing plates of rings of material inherent in the branch. It is the Contractor's responsibility to provide reinforcement wherever necessary for branch connections. Welded branch connections are not an acceptable alternative where tees have been specified unless specific approval of the Engineer is obtained.
- 6.1.8 All threads on piping components shall be taper piping components shall be taper pipe thread as per applicable standards. The threads shall be concentric with reference to outside of the pipe and free from defects. Threading of pipe shall be preferably done after bending, forging or heat treatment operations. When this is impossible or very difficult to perform, threading may done prior to such operations but shall be taken to properly protect the threads from damage.
- 6.1.9 Where miter bends have been specified in the piping materials specification sheets, the miter shall be of three weld type with liner angle 30⁰ each and outer angles 15⁰ each.
- 6.1.10 Where fabricated reducers have been specified, they shall be fabricated from parent pipes by the 'cut and shut' method. However, per mandrels shall be used to obtain the best possible profile of the reducer.

6.2 Welding procedures.

- 6.2.1 The welding methods used for Mild Steel pipe fabrication shall be Shielded Metal Arc Welding (SMAW) process for all the passes and welding shall be in accordance with Section-IX of the ASME code. Welding procedure, weld materials and welders shall be qualified in accordance with ASME Section-IX code and shall be approved by the purchaser before commencement of fabrication of piping. Welds shall be free from undercuts, overlaps and porosity etc,
- 6.2.2 **Precautions for welding:** All surfaces to be joined shall be thoroughly cleaned by steel brush at least at a distance of 15 mm from every joint to prevent weld contamination. The surface of the welding shall be free of scale, rust, oil, grease or other foreign material. The work and weld material shall be protected from rain and wind during welding. No welding shall be performed on wet surfaces. The fabricator is responsible

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

for control of welding materials, which are used in the fabrication of EP's. Suitable identification, storage and handling of welding materials shall be maintained.

6.2.3 **Miscellaneous welding requirement:** In multi pass welding after each pass any porosity, lack of penetration, inclusions or other defects and all slag, oil, penetrate or other foreign materials shall be completely removed before subsequent penetrate are applied. Covering over or penning of any serious defect or contaminant shall be a cause for rejection. Penning of any weld pass shall not be permitted on reverse side of root passes shall be back chipping or ground back to clean metal and then finished. No arc gauging is permitted.

6.2.4 **Workmanship and general cleanliness:**

All welds on the surface of the pipes shall be finished smooth and flush with the parent metal. Any scratch, dent or mark which occurs during fabrication or shipment shall be repaired to the satisfaction of the purchaser. No permanent marking or stamping shall be permitted. The general surface finish shall be goof. All scale, oxide, oil and other foreign material shall be completely removed from pipes. All surfaces that will not permit internal cleaning after complete fabrication and assembly shall be cleaned of all foreign material visible to the naked eye prior to assembly. Adequate precautions such as the fitting of temporary covers to all external ends of pipes shall be taken to ensure that this state of cleanliness is maintained till the completion of work. Particular care should be taken to ensure that all piping for pipes are kept clean and free from any matter which could obstruct the flow. All precautions necessary shall be taken to protect the surface from any damage.

7. CLEANING, FLUSHING AND BLOWOUT.

7.1 The Contractor before shall clean all piping including valves and specialties and during erection to remove grease, dirt, dust, scale and welding slag.

7.2 Before erection, all fabricated pipe work, assemblies, sub-assemblies, fittings and components etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes. The brushes shall be the same or similar materials as the metal being cleaned.

7.3 After erection, lines shall be mass flushed with water. The cleaning velocities in process and utility lines shall be 1.2 to 1.5 times the operating velocities in the pipelines. The strainers, traps, control valves, inline instruments shall be replaced by spool pieces.

8. QUALITY ASSURANCE, INSPECTION AND TESTING

8.1 GENERAL REQUIREMENT:

8.1.1 All the materials supplied under this contract shall be subjected to all shop tests as per applicable materials standards.

8.1.2 The Owner's representatives shall at all responsible times, have facility to witness the contractor's operator's qualification tests conducted by the Contractor. They shall also have access to the Contractor's heat treatment records and magnetic particles, fluorescent particle records, reports of repair etc.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 8.1.3 Any workmanship by the Contractor/his Sub-Contractor inspected in the field and found not to comply with this specification or any of its parts shall be repaired at the Contractor's expense, if the non-compliance is the fault of the Contractor. The fact that Owner/Engineer has not relived the Contractor from correcting such work as directed by Owner/Engineer without additional compensation.
- 8.1.4 On completion of erection, the inside of all pipes valves fittings etc. shall be clean from loose scale and foreign matter before subjecting the line to any test/inspection. Orifice plates should not be erected until hydrostatic testing and cleaning operation are completed.
- 8.1.5 Lines having check valves should have the source of test pressure located on the upstream side.
- 8.1.6 After pressure test, any leaky joints shall be cut out and repaired or completely replaced and tested repeated until the test has been satisfactory passed.
- 8.1.7 After completion of hydrostatic test, safety valves, orifice plates etc. withheld for the hydrostatic tests, shall be installed in an approved manner. Orifice plates shall however, the installed after compellation of cleaning operations.
- 8.1.8 Clean water at temp. of not less than dew point or 10⁰C whichever higher, not exceeding 50⁰C should be used for hydrostatic test.
- 8.1.9 After hydro tests, lines shall be drained thoroughly. When draining the fluid, the pipelines should be vented slowly to avoid excessive vacuum. Lines for the process service and stainless-steel lines shall be air-dried.
- 8.1.10 Only calibrated test gauges should be used and shall be mounted in the upright position. Pump discharge gauge must be visible to the pump operator for the duration of the hydro test.

8.2 HYDRO TESTING: All piping system shall be tested hydro statically to 1.5 times the maximum allowable working pressure by the Contractor, after erection. The test pressure shall be maintained until all welded/flanged joints are inspected for leakage or at least for ten minutes.

8.3 Weld tests and Inspections:

Dye penetrant tests: All weld passes shall also be examined by the dye penetrate test as per ASTM E 165. All defects shall be repaired and re-tested. The penetrate material used shall satisfy the limits for Sulphur and halogen contents as per ASTM specifications.

9. PAINTING:

After Piping has erected and successfully commissioned and tested shall be painted with 2 coats of red oxide primer and 1 coat of Poliamide base epoxy paint over two coats of epoxy resin based zinc chromate primer. Before paint is applied the surface shall be dry and free from rust, dirt, scale and grease .

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

10. EXECUTION OF CONTRACT:

- 10.1 Copies of all material and other shop test certificates shall be submitted to the Owner /Engineer regarding the progress of procurement/inspection.
- 10.2 The Contractor shall advise the Owner/Engineer regarding the progress of procurement /inspection/dispatch of materials at site.
- 10.3 Before commencement of fabrication/erection of piping system, the Contractor shall ensure that the drawings available with him are the latest issues as on date and shall be obtain a certification from the Owner/Engineer.
- 10.4 No work shall be carried out in areas indicated to be under ‘Hold’ in Owner’s drawings and documents until such time the ‘Holds’ are cleared by the Owner/Engineer.
- 10.5 The Contractor shall prepare detailed bills of piping materials based on the Owner/Engineer’s lay out drawing/isometric and/or his own isometric and fabrication drawings. After completion of work, the Contractor shall submit the finial bills of materials in the Owner along with as built markup of Owner’s layout drawings/isometric and as built issues of the drawings prepared by him.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Appendix-I
Technical Datasheet – A1
Butterfly Valves (Manual)

1.	General:	
	Type	Double eccentric disc, Wafer type
	Service Fluid	Chilled/Condenser Water
	Operating Temperature	6 to 45 Deg. C (max.)
	Operating Pressure	As per design requirements
	Rating	ANSI CL. 150
	Allowable Leakage	Nil (Drip-tight shut off)
	Design Standard	BS 5155
2.	Construction Features:	
	End Connection	Wafer
	Operator	Heavy duty Gear Operated
	Sealing Element	Integrated Moulded Seal ring
	Stem Seal	Gland packing with O-rings
	Stem Locking	Provision at every 10 ⁰ of opening
Bi-Directional	Yes/No	
3.	Material of Construction:	
	Body	ASTMA 216 WCB
	Disc	ASTM A 351 CF 8/8M
	Seal Ring	PTFE
	Stem	ASTM A 276 Gr. SS 316
	Stem Bearing	PTFE/RTFE
	Gland Packing	PTFE
	Companion Flanges	ASTM A 105
	Lever/Hand wheel	AISI 304
	O-Ring	EPDM
	Gear Unit	SG Iron
4.	Inspection & Testing:	
	Raw material Check (100%)	Physical and Chemical tests
	Dye Penetrant Test (100%)	Cast/Forged components
	Hydro test	Valve Shell and Seat
	Pneumatic Test	Valve Seat
	Testing Standard	BS 6755

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Appendix-II
Technical Datasheet – A2
Butterfly Valves (Pneumatic/ Motorised with manual override)

1.	General:	
	Type	Double eccentric disc, Wafer type
	Service Fluid	Chilled/Condenser Water
	Operating Temperature	6 to 45 Deg. C (max.)
	Operating Pressure	As per design requirements
	Rating	ANSI CL. 150
	Allowable Leakage	Nil (Drip-tight shut off)
	Design Standard	BS 5155
2.	Construction Features:	
	End Connection	Wafer
	Operator	Pneumatic Actuator (with Solenoid Valve)/ Motorised actuator with manual override and on/off limit switches
	Sealing Element	Integrated Moulded Seal ring
	Stem Seal	Gland packing with O-rings
	Stem Locking	Provision at every 10 ⁰ of opening
	Bi-Directional	Yes/No
3.	Material of Construction:	
	Body	ASTMA 216 WCB
	Disc	ASTM A 351 CF 8/8M
	Seal Ring	PTFE
	Stem	ASTM A 276 Gr. SS 316
	Stem Bearing	PTFE/RTFE
	Gland Packing	PTFE
	Companion Flanges	ASTM A 105
	Lever/Handwheel	AISI 304
	O-Ring	EPDM
	Gear Unit	SG Iron
4.	Inspection & Testing:	
	Raw material Check (100%)	Physical and Chemical tests
	Dye Penetrant Test (100%)	Cast/Forged components
	Hydro test	Valve Shell and Seat
	Pneumatic Test	Valve Seat
	Testing Standard	BS 6755
5.	Pneumatic Actuator with manual override:	
	General:	
	Type	Compact, Double acting, rotary type using double rack and pinion
	Air Pressure	4 Kg/cm ² g (Operating)&7 Kg/cm ² g (Maximum)
	Construction Details:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

	Stroke Limiting Provision	Yes/No
	Allowable Leakage	Nil
	Valve Mounting	As per ISO 5211
	Material of Construction:	
	Body	Hard anodized Aluminium
	Piston	Die cast Aluminium
	Pinion	Electroless nickel plated
	O-Rings	EPDM
	Inspection and Testing:	
	Pneumatic Test (100 %)	To check leak through pinion shaft seal and end closures
	Performance Test (100 %)	To check maximum torque.
	Life Test (one of each type)	Test for 50,000 cycles of operation
6.	Solenoid Valves:	
	General:	
	Type	4/2, Namur mounted
	Air Pressure	4 Kg/cm ² g (Operating) 7 Kg/cm ² g (Maximum)
	Power Supply	48 V DC
	Construction Details:	
	Allowable Leakage	Nil (Tight shut off)
	Coil Protection	IP 67
	Valve Mounting	Namur, as per ISO 5211
	Ports	¼ inch NPT (IF) as per ANSI B 2.1/2.2
	Coil Construction	Resin molded
	Insulation Resistance	More than 100 Mega-ohm at 500 V DC
	Coil Power Rating	2 W
	Material of Construction:	
	Body	Aluminium
	Seat	Teflon/Viton
	Inspection and Testing:	
	Hydrostatic Test (100 %)	To check leak through closed ports
	Seat Leak Test (100 %)	To check leak across valve seat
	Life Test (one of each type)	Test for 25,000 cycles of operation

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Appendix-III
Technical Datasheet – A3
Globe Valves (Manual)

1.	General:	
	Type	Tapered plug type disc suitable for throttling
	Service Fluid	Chilled/Condenser Water
	Operating Temperature	6 to 45 Deg. C (max.)
	Rating	ANSI CL. 150
	Allowable Leakage	Nil (Drip-tight shut off)
	Design Standard	BS 1873
2.	Construction Features:	
	End Connection	Butt-welded end
	Operator	Hand wheel
	Seat	Body - Replaceable Disc - Integral
	Stem	Outside screw rising stem
	Bonnet	Bolted
3.	Material of Construction:	
	Body/Bonnet	ASTMA 216 WCB
	Disc Seat	ASTM A 351 CF 8/8M
	Body Seat	PTFE
	Stem	ASTM A 276 Gr. SS 316
	Bonnet Gasket	PTFE/RTFE
	Gland Packing	Graphite/PTFE PTFE
	Flanges	ASTM A 105
	Hand wheel	AISI 304
4.	Inspection & Testing:	
	Raw material Check (100%)	Physical and Chemical tests
	Dye Penetrant Test (100%)	Cast/Forged components
	Hydro test	Valve Shell and Seat
	Pneumatic Test	Valve Seat
	Testing Standard	BS 6755

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Appendix-IV
Technical Datasheet – A4
Ball Valves (Manual)

1.	General:	
	Type	3-piece, Full bore, Quarter turn
	Service Fluid	Chilled/Condenser Water
	Operating Temperature	6 to 45 Deg. C (max.)
	Rating	ANSI CL. 150
	Allowable Leakage	Nil (Drip-tight shut off)
	Design Standard	BS 5351
2.	Construction Features:	
	End Connection	Socket welded end
	Operator	Lever
	Seat	Replaceable molded seat
	Stem	Blow-out-proof stem
	Surface Finish of Ball	Mirror finish (for positive shut-off and low operating torque)
3.	Material of Construction:	
	Body	ASTMA 216 WCB
	Ball	ASTM A 351 CF 8/8M
	Body Seal	PTFE
	Seat	ASTM A 276 Gr. SS 316
	Stem	ASTM A 276 Gr. SS 316/304
	Stem Seal	PTFE
	Gland Packing	Graphite/PTFE
	Lever	AISI SS 304
4.	Inspection & Testing:	
	Raw material Check (100%)	Physical and Chemical tests
	Dye Penetrant Test (100%)	Cast/Forged components
	Hydro test	Valve Shell and Seat
	Pneumatic Test	Valve Seat
	Testing Standard	BS 6755

Note: Suitable actuators shall be provided as per chiller plant design requirement.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Appendix-V
Technical Datasheet – A5
Gate Valves (Manual)

1.	General:	
	Type	Plain wedge
	Service Fluid	Chilled/Condenser water
	Operating Temperature	6 to 45 Deg. C (max.)
	Rating	ANSI CL. 150
	Allowable Leakage	Nil (Drip-tight shut off)
	Design Standard	BS 1414
2.	Construction Features:	
	End Connection	Butt-welded end
	Operator	Hand wheel
	Seat	Body - Replaceable
		Wedge - Integral
	Stem	Outside screw rising stem
	Bonnet	Bolted
3.	Material of Construction:	
	Body/Bonnet	ASTMA 216 WCB
	Wedge Seat	ASTM A 351 CF 8/8M
	Body Seal	PTFE
	Stem	ASTM A 276 Gr. SS 316
	Bonnet Gasket	CAF, IS 2712 Gr. WA3
	Gland Packing	Graphite/PTFE
	Hand wheel	Stainless steel
4.	Inspection & Testing:	
	Raw material Check (100%)	Physical and Chemical tests
	Dye Penetrant Test (100%)	Cast/Forged components
	Hydro test	Valve Shell and Seat
	Pneumatic Test	Valve Seat
	Testing Standard	BS 6755

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

**ANNEXURE I
TECHNICAL DATA SHEET FOR CONDENSER AND CHILLED WATER PIPING**

1	Condenser Water Piping	:	
1.1	Pipe Material (Make/Quality/Grade)	:	
1.2	Size (OD X Thickness/Class)	:	
2	Chilled Water Piping	:	
2.1	Pipe Material (Make/Quality/Grade)	:	
2.2	Size (OD X Thickness/Class)	:	
3	Chilled water piping Insulation	:	
3.1	Material of Construction (Make/Quality/Grade)	:	
3.2	Thickness	:	
3.3	Details of Insulation	:	
4	Pipe fittings/Structural pipe supports	:	
4.1	Flanges (Make/Quality/Grade)	:	
4.2	Bends (Make/Quality/Grade)	:	
4.3	Bolts and Nuts (Make/Quality/Grade)	:	
4.4	Gaskets (Make/Quality/Grade)	:	
4.5	Pipe supports (Make/Quality/Grade)	:	
5	Valves	:	
5.1	Butterfly Valves (Make/Quality/Grade/Actuator)	:	
	Material of construction (Body/Seat/Disc)	:	
5.2	Non-return Valves (Make/Quality/Grade)	:	
	Material of construction (Body/Seat/Disc)	:	
5.3	Gate/Globe Valve (Make/Quality/Grade/ Actuator)	:	
	Material of construction (Body/Seat/Disc)	:	
5.4	Strainers (Make/Quality/Grade)	:	
	Element details (Material/Mesh size)	:	
5.5	Automatic self-cleaning Strainer (Make/Quality/Grade)	:	
	Element details (Material/Mesh size)	:	
5.6	Control valve for primary variable flow with electrical actuator	:	
	Material of construction (Body/Seat/Disc)	:	
	Manual/ Pneumatic / Electric Actuator	:	
5.5	Fabrication & Welding	:	
	Welding Process employed	:	
	Welding electrodes (Quality)	:	
6	Quality assurance/Inspection & Testing	:	
6.1	D.P. Testing (Confirmed to specification) Yes/No	:	
6.2	Hydro testing(Confirmed to specification)	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

	Yes/No		
6.3	Qualification of Welders Yes/No	:	
6.4	Quality assurance/Inspection & Testing	:	
6.5	D.P. Testing (Confirmed to specification)	:	
6.6	Hydro testing (Confirmed to specification)	:	
6.7	Qualification of Welders	:	
6.8	Painting (Make /Quality/Grade/Rating)	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

PART-II-F

TECHNICAL SPECIFICATION OF MOTOR

1. SCOPE:

This specification covers technical requirements for the design, manufacture, inspection, testing, packing for shipment and supply of squirrel-cage induction motors of reputed make complete with mounting, bed plate etc. required as prime movers for and as an integral part of Chiller Compressor, Chilled water/ Condenser cooling water pumps, Cooling tower fans, as specified in this document.

Intent of the specification is that the tenderer should select a squirrel-cage induction motor of appropriate rating, compatible with the above-mentioned equipment. The tenderer shall furnish superimposed Torque-Speed characteristics for the motors and the driven equipment under VFD mode of starting, along with the other performance data and curves for the offered motors.

Annexure 'I' - Specific requirement sheet for squirrel-cage induction motors and this specification is meant only for guidance of the supplier and is not intended to cover all aspects of design, manufacture and testing.

2. STANDARDS

Unless they are conflicting with the clauses of this specification, the squirrel-cage induction motors and its components, shall comply with the latest applicable Indian Standards listed below. Where Indian Standards don't exist, the relevant IEC, British or German (VDE) standards shall apply. If this specification has conflict in any way with any of the above standards, this specification shall govern.

1. IS-1231-1974 : Dimensions of 3-phase foot-mounted induction motors.
2. IS-1271-1985 : Specification for Thermal evaluation and classification of electrical insulation. (First Revision)
3. IS-2253-1974 : Designation for types of construction and mounting arrangements of Rotating electrical machines.
4. IS-2254-1985 : Dimensions of vertical shaft motors for pumps.
5. IS-4029-2010 : Guide of testing three-phase induction motors.
6. IS-4889-1968 : Methods of determination of efficiency of rotating electrical machines.
7. IS-6362-1995 : Designation of methods of cooling for rotating electrical machines.
8. IS-9628-1980 : Specification for Three phase induction motors with type of protection "n".
9. IS-12065-1987 : Permissible limits of noise level for rotating electrical machines.
10. IS-12075- : Mechanical Vibration of Rotating Electrical Machines with Shaft

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 2008 Heights 56 mm and Higher - Measurement, Evaluation and Limits of Vibration Severity.
11. IS-12615-2018 : Line operated 3-phase AC motors (IE Code) “Efficiency Classes & Performance Specification”.
12. IS/IEC 60034-1: 2004 : Rotating Electrical Machines - Part 1: Rating and performance.
13. IS/IEC 60034-5: 2000 : Rotating Electrical Machines - Part 5: Degrees of protection provided by the integral design of Rotating Electrical Machines (IP code) – Classification.
14. IS/IEC 60034-8: 2002 : Rotating Electrical Machines - Part 8: Terminal markings and direction of rotation.

3. DESIGN REQUIREMENTS

3.1. General

3.1.1 Motors shall be designed, manufactured and equipped with accessories in accordance with this specification and the applicable standards indicated in clause 2. Materials and components, not specifically stated in this specification and which are necessary for meeting the requirements of this specification and/ or the main equipment to be driven, shall be included in the scope of supply.

3.1.2 The intent of this specification is that the contractor supplying the equipment shall provide motors which shall be suitable for properly starting the end operating Chiller Compressor, Chilled water/ Condenser cooling water pumps, Cooling tower fans, specified in part II- B & C of this tender document, under operating and environmental conditions specified in this tender.

3.1.3 Design and manufacture of the motors shall be coordinated with the requirements of the driven equipment i.e., Chiller Compressor, Chilled water/ Condenser cooling water pumps, Cooling tower fans. The motor manufacturer shall co-operate fully with the purchaser and manufacturer of the driven equipment by furnishing the following information necessary for assembly and operation of unit as a whole:

- i) A fully dimensioned outline drawing of the motor.
- ii) The relevant motor characteristics viz. speed/ torque, speed/ current etc.
- iii) Weight of motor.

The design and workmanship shall be in accordance with best engineering practices to ensure satisfactory performance and service life as specified herein.

The supplier of the main equipment i.e., Chiller Compressor, Chilled water/ Condenser cooling water pumps, Cooling tower fans complete with motor, shall make available to motor manufacturer, a copy of this specification and shall be responsible to the purchaser for

coordinating with the motor manufacturer for the supply of the required motor and accessories and for satisfactory operation of complete unit.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

If in the opinion of the supplier, motor with specifications in any way different from this specification, is required for satisfactory operation of the centrifugal pumps, alternative offer, with extra charges, if any, shall be indicated, giving details of deviation from this specification.

3.2. Operation Conditions

3.2.1. Voltage and Frequency Variations

Motors shall be designed to deliver rated output at rated power factor, continuously with: -

- a) Motor terminal voltage variations as 6600V/ 415 V \pm 10%.
- b) Frequency differing from 50 Hz by \pm 5%.
- c) Any combination of a and b.

In case of operation at extreme voltage limits, the specified temperature rise limits shall not exceed by more than 5°C. Machines when operated under abnormal conditions of voltage and frequency variation may not necessarily have their performance in accordance with the relevant standards mentioned in clause 2 above.

The supply voltage may be assumed to be virtually sinusoidal and virtually balanced as defined in IS 12615- 2018.

3.3. Temperature rise

Motor windings shall have insulation of Class F. The temperature rise of the motor windings shall be limited to that for class B insulation.

3.4. Starting duty

3.4.1. The motors shall be capable of starting and accelerating the driven equipment satisfactorily at a minimum voltage of 80% of the nominal voltage at the motor terminals.

3.4.2. Under cold condition, at room temperature, the motors shall be capable of three successive starts with a time interval of one minute between each successive starting operation and fourth and fifth start at 20 minutes interval.

3.4.3 Under hot condition, the motor shall be capable of two starts in quick succession (the time interval between each starting operation being less than one minute) and a third start 20 minutes later and each subsequent hot start at 4 hours interval, and the motor shall withstand all stresses and give satisfactory performance.

3.4.4 All motors except that used in Chilled water compressor shall be energy efficient (IE-3) and inverter duty type. Motors shall also be designed for VFD starting (driven equipment coupled to it) with winding braced to withstand all stresses and give satisfactory performance when started with their driven equipment connected.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

Each coil shall be tied to the adjacent coils in such a manner that all relative movement between coils is reduced to a minimum.

3.4.5 Motor windings shall have PTC thermistor or equivalent thermal overload protective device embedded in windings. VFD shall be compatible for termination of inputs of thermistor or equivalent thermal device from motors. Wiring for PTC thermistors/ equivalent thermal device from motor to VFD panel shall be carried out by the contractor using FRLS PVC wires of suitable size.

3.4.6 Under emergency conditions and during commissioning, the motor initially at room temperature, shall be capable of the following starting duty:

- i. Two successive restarts with coasting to rest between the starts.
- ii. Further two successive starts with coasting to rest between the starts after an interval of 20 minutes from the restarts mentioned in (a).
- iii. Third set of two successive restarts with coasting to rest between the starts after a further interval of 20 minutes from the restarts mentioned in (b)
- iv. After these a rest period of 24 hours.

3.4.7 With the motor initially at operating temperature, it shall be capable of the following start duties:

- a) Two immediate restarts with time interval of 30 sec. to 60 sec. between the starts.
- b) Further two such successive restarts after an interval of 30 minutes from the restarts mentioned in (a).
- c) Fifth start 30 minutes after fourth.
- d) After these, a rest period of 24 hours.

The tenderer shall state in the tender that those starting requirements can be met without any damage to the motor.

3.5. Breakaway starting current

Breakaway starting current of motors shall have the lowest value consistent with good performance and economic design for their torque current class, but this shall not exceed 600% of full load current.

3.6. Fast bus transfer

Motors shall be capable of withstanding the voltage torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of motor rated voltage during fast changeover of the supply. Expected duration of dead time will be about 200 milliseconds. Features incorporated in the motor design to comply with this requirement, shall be clearly indicated in the proposal.

3.7. Pull out torque

During normal running, the supply voltage may fall to 70% of the rated motor voltage

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

for a short duration of 25 cycles. It shall be possible for the motor to provide the required torque under this condition. To meet this requirement, the pull-out torque of the motor at rated voltage shall be at least 200% of full load torque.

3.8. Overload

The motors shall be capable of withstanding, for 10 sec., without stalling or abrupt change in speed (under gradual increase of torque), an excess torque of 60% of their rated torque, with the voltage and frequency being maintained at their rated values.

3.9. Over Speed

The motors shall be capable of withstanding without mechanical damage at least 120% of rated speed for 2 minutes.

3.10. Efficiency

The efficiency values for the motors offered at 50%, 75% and 100% load shall be as per IS 12615.

3.11. Noise Level

The permissible noise level shall not exceed 85 dB.

3.12. Critical speed

The first critical speed of the motor shall be a minimum of 125% of rated motor speed to ensure that the first critical speed of the driven equipment - motor combination will be above the rated speed.

3.13. Vibrations

Motor vibration shall be within the limits of IS 12075, unless otherwise specified for driven equipment.

3.14. Other requirements

3.14.1 Motors shall be capable for satisfactory operation at full loads for 10 minutes without injurious heating for the motor terminal voltage of 80% of rated voltage.

3.14.2. Accelerating time of the motor with rated driven equipment load connected to it, shall not exceed the corresponding safe stall time of the motor, even if stalling occurs when motor is at rated operating temperature.

3.15. Environment conditions

Climatic condition: Typically highly humid (100% at 45°C), heavy rainfall (2000 mm), conducive to rust and fungus growth, besides being close to Arabian Sea coast, the environment is laden with salt spray.

Ambient Temperature: 50°C maximum, 16°C minimum.

35°C yearly average temperature.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

4. CONSTRUCTION DETAILS AND OTHER REQUIREMENTS

4.1 ENCLOSURES

All motors except that for chiller compressor shall be self-ventilated and suitable for indoor installation. Motors except that for chiller compressor shall be of the TEFC type. The motor frames may be of rigid fabricated steel.

The compressor motor shall be semi-hermetically sealed & liquid refrigerant cooled. This refrigerant flow circuit shall be isolated from main refrigerant flow circuit so that any contamination generated by the motor fault will not pass into the main refrigerant circuits.

4.2 ROTOR

For motors of rating up to 30 kW, rotor construction shall be of die cast aluminium. For motors of rating above 30 kW, the rotor design shall provide a rigid cage construction with copper bars firmly wedged in bar slots and solidly bounded to the end rings. The end ring assembly shall be such that it is free to move with the expansion of the bare rotor bars without any distortion and withstand mechanical stresses for the type of duty specified. The motor cage shall be designed to operate satisfactorily under respective starting and load cycles.

The ability of the cage construction to provide satisfactory operation under respective starting cycles and load cycling shall be a matter of close attention during design and manufacture and this feature of the motor design shall be fully described in the tender.

The motor shall be capable of operating on full overspeed requirement imposed by the driven equipment in the forward and reverse direction. The rotor bars shall be insulated in the portion between the slot walls and the bars. The tenderer should furnish the details of construction provided to meet starting and load cycle duty. Winding overhangs of all motors shall be given epoxy gel coating.

4.2.1 Shaft

The motor shaft shall be made of EN8 or equivalent material. The motors will be directly coupled with the driven equipment. Hence the shaft should have adequate extension. The shaft should also have adequate strength to withstand stresses due to overhang, weight of the pulley and other mechanical forces due to misalignment. Exact details of the driven equipment should be made available to the motor manufacturer by the contractor (or by the manufacturer of the driven equipment).

4.3 Frame

The motor frame may be of rigid fabricated steel or casting. The material shall be of

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

reputed make.

4.3.1 Frame size

It may be noted that class F insulation as specified should not be used at the cost of lower frame size. The frame size should be selected as is required for normal class B insulation motor with the same H.P. rating.

4.4 TERMINAL BOXES

Separate terminal boxes shall be provided for each of the following:

- a) Stator leads.
- b) Space heaters.
- c) Temperature detectors.
- d) The terminal box shall be suitable for top and bottom entry of cables and shall be provided with suitable gasket on the covers to make it moisture proof. Terminal box on cooling tower fan motors shall be weatherproof. Gasket of neoprene or approved equivalent shall be provided at cover joints and also between the box and the motor frame. All terminal boxes shall be provided with cable boxes/ glands of adequate size of equipment rating. The exact number and size of cable would be intimated to successful supplier. The size of terminal box should have ample space to cater for bending radius of cables as per regulations and also for terminating aluminum conductor cables. The terminal block of the motor shall be fixed at the centre on the top of motor casing, as viewed from DE of the shaft.

4.5 BEARING AND BEARING HOUSING

Motor bearings shall be constructed so as to exclude dirt and water and to prevent lubricant from reaching the windings. Motors shall have anti-friction/ journal bearings in cartridge housing. Insulated bearings shall be used for inverter duty motors. Bearings shall generally conform to relevant clause of the equipment specifications. The details regarding make, type and other data of the bearings used shall be furnished.

4.6 INSULATION

All motors shall be provided with Class F insulation except when stated otherwise. Motor winding shall be given special tropical, fungicidal and 'power house' treatment for protection against tropical weather conditions, fungus growth and moisture, oil, abrasive and conducting dust and sulphur fumes in combination with weak acid or alkali fumes respectively that are likely to be encountered in and around the plant area.

'Power house treatment' shall comprise of an additional treatment to the winding, over and above the normal treatment generally given to such winding by the manufacturer. In this, after the coils are placed in slots and all connections are made, entire motor assembly shall be impregnated by completely submerging core and windings in suitable

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

insulating compound or varnish followed by baking. At least two additional submersions and bakes shall be applied either to the end windings or to the whole assembly, making a total of at least three submersions and bake treatments. Any joints in motor insulation such as at coil connections or between slot and end-winding sections, shall have protection equivalent to that of the slot sections of the coils.

The insulation system shall provide the maximum protection against damage due to moisture and fungi and shall be suitable for operation in the tropical climate. The selection of insulating materials, varnish and the treatment thereof should be done with such meticulous care that the I.R. value of the motor does not fall below the prescribed limit while idling on standby duty under the worst humid conditions.

The supplier shall fully describe the insulation and insulating treatment together with its capacity for sustaining, without any damage, the operating environment and temperature involved.

4.7 DIRECTION OF ROTATION

Definition

The direction of rotation shall refer to the non-drive end of the machine. All motors shall be designed for operation in either direction of rotation marked on the stator frame or on the name plate.

4.8 GROUNDING

Provision shall be made on the motors for connecting purchaser's grounding conductors. Two independent grounding points shall be provided on each motor frame on opposite sides near the bottom.

For compressor motor, copper earth bars of suitable size shall be provided for earthing purpose.

4.9 GENERAL

4.9.1 Unless otherwise approved by Purchaser, motors shall be designed to permit convenient access for drilling vertically through motor feet or mounting flange for installation of purchaser's dowel pins after motors are mounted with driven equipment.

4.9.2 If the motor is supplied with driven equipment having a common bed plate to keep vibration and misalignment within permissible limits, the bed plate drawing shall be approved by the motor manufacturer.

4.9.3 Motor weighing more than 25 kg shall be provided with eye bolts, lugs or other devices to facilitate safe lifting operations.

4.9.3 All motor dimensions shall be in millimeters and shall be subject to tolerance specified in IS 1231, IS 2223 and IS 2254. All nuts, studs and bolts, subject to periodic removal for maintenance purpose, shall be designed and fabricated to metric units.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- 4.9.4 All motors shall have anti-condensation space heaters. Wiring for space heater from VFD panel to motor shall be carried out using FRLS PVC wires of suitable size. Space heater shall be wired in such a manner that when VFD is de-energized, space heater shall be switched ON and vice versa.
- 4.9.5 Each motor shall have a name plate showing all the particulars specified in relevant standard. In addition, the following information shall be included in the name plate:
- a) Temperature rise in °C at rated load.
 - b) Type of bearings and recommended lubricant.
- 4.9.6 The motors offered should be of repute make.

4.10 PAINTING AND PACKING

- 4.10.1 The motor external parts shall be furnished and painted to produce a neat and durable surface, which would prevent rusting, and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edge and scales removed and treated with one coat of primer and finished with two coats of enamel/ epoxy-based paint.
- 4.10.2 These motors shall be packed for dispatch to project site in strong wooden crates. The following information shall be clearly given on each box.
- a) Purchaser's Name.
 - b) Purchase Order No.
 - c) Equipment codes No., if any.

5 INSPECTION, TESTS AND GUARANTEE

- 5.1 Each motor shall be tested completely in accordance with the latest standards and this specification, which includes vibration, speed-torque characteristics, noise and shaft current tests. Each motor shall also be successfully tested on overspeed at 120% of rated speed for 2 minutes. Internal test reports shall be submitted for review.
- 5.2 In the event of failure of the motor or any part to fully meet any specifications or test requirement specified herein, the Contractor shall notify the purchaser or authorized representative if he wishes to repair and/ or to use such motor or part. If the repairs including redesign are likely to affect the result of tests or work previously completed, appropriate re-inspection and resetting shall be conducted at Contractor's expense.
- 5.3 Type tests for motors shall be conducted as per relevant code i.e IS: 12615 by the manufacturer at his works. Type test for LT motors for pumps & cooling tower testing will be witnessed by the Purchaser's representative. However, HT motor will be tested during chiller performance testing at chiller manufacturer works. The supplier shall notify purchaser prior to the performance of the above test so that he may be present during the tests. Copies of the internal test certificates of HT & LT motors shall be furnished to the Purchaser for review.
- 5.4 Routine tests of motors shall be conducted as per relevant code i.e IS: 12615 by the manufacturer. Routine test for LT motors for pumps & cooling tower testing will be witnessed by the Purchaser's representative. However, internal test report for HT motor routine testing internal reports shall be submitted by supplier for BARC review and

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

motor testing will be witnessed by purchaser during integrated testing of chillers along with its compressor and motors. The supplier shall notify purchaser prior to the performance of the above test so that he may be present during the tests. Copies of the internal test certificates of HT & LT motors shall be furnished to the Purchaser for review.

- 5.5 The supplier shall perform all the necessary inspection and testing to ensure that the material equipment and workmanship are in accordance with the stipulations of this specification.
- 5.6 The Purchaser's inspector shall, at all reasonable times, have access to those parts of the Sub-supplier's works concerned with the manufacture of the motors, for the purpose of witnessing tests and ascertaining compliance with the requirements of this specification. The Purchaser shall also have the right to conduct at his expense, any additional tests or inspection, he deems necessary.
- 5.7 Supplier shall furnish material inspection certificates for motor shaft and bearing and he shall be in a position to correlate these certificates with the actual materials used for the motors.

6 DRAWING

As soon as the purchase order is issued by the purchaser, supplier shall submit within 4 weeks for the purchaser's approval, 4 copies each of certified dimensioned outline drawings of the motors, terminal boxes and bearings. Supplier shall take up manufacture of the motors only after Purchaser has approved the drawings. After execution of the order, 4 copies of as-built drawings shall be supplied to the purchaser.

7 INSTRUCTION BOOKS:

Supplier shall furnish 4 copies of instruction manuals covering installation, operation and maintenance of the motors. Installation instructions shall include procedure for checking alignment of motor shaft, coupling and base. Instruction shall also cover lubricating details including recommended inspection and replacement schedules, quantity of lubricant required and specifications for the lubricant and its equivalent.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

ANNEXURE -I

Technical particulars for motors for Chiller Compressor, Chilled water/ Condenser cooling water pumps, Cooling tower fans.

- 1 Site & Operating conditions
 - 1.1 Ambient Temperature : 45 °C
 - 1.2 Accidental rise in surrounding : 5°C above normal room temp., lasting for max. 5 minutes
 - 1.3 Atmosphere : Typically, highly humid (100% at 45°C), heavy rainfall (2000 mm), conducive to rust and fungus growth, besides being close to Arabian sea coast, the environment is laden with salt spray.
 - 1.4 Altitude above m.s.l : Not exceeding 1000 m.
- 2 Applicable standards : As per Clause 2 of this technical specification.
- 3 Type of enclosure and degree of protection : T.E.F.C., IP 55 as per IS/IEC 60034-5 (except for Chiller compressor)
- 4 Type of duty : Continuous
- 5 Frequency : 50 Hz
- 6 No. of phases : Three
- 7 Mechanical input in KW : To suit the equipment's requirements for operation at 120% of the designed capacity or to suit the design requirement of the equipment with 15% margin, whichever is higher.
- 8 Rated voltage : 6600/ 415 volts
- 9 Class of insulation : "F"
- 10 Speed in revolutions per minute : 1500 rpm at rated output.
- 11 Direction of rotation : The motor shall be suitable for bi-directional rotation.
- 12 Maximum temperature of the cooling air in the place where the motor is intended to work in normal : 50 °C.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

service.

- 13 Maximum temperature rise : Refer clause 3.3 of the specification of motors.
- 14 Limits of voltage and frequency between which the motor is required to operate continuously and satisfactorily. : 6600V/ 415 V \pm 10% Hz/ 50 Hz \pm 5%.
- 15 System Earthing : Earth-electrode grounding system for Equipment. Motor body to be connected to earth electrode through copper conductor at two different places.
- 16 Particulars of tests : All type, routine and special tests as specified as per IS 12615 & IS-4029 are to be carried out at motor manufacturer's place.
- 17 Rotor : Squirrel cage.
- 18 Details of shaft extension : As per the requirement of the driven equipment.
- 19 Method of starting to be employed : VFD starting (motors except for chiller compressor shall be energy efficient (IE-3) & of inverter duty type)
- 20 Breakaway torque : To suit the driven equipment.
- 21 Breakaway starting current : Not exceeding 600% of FL current.
- 22 Details of driven equipment : Refer the equipment ratings as per final selection of equipment and specification.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

**ANNEXURE-II
TECHNICAL DETAILS FOR MOTORS TO BE FURNISHED**

1.	Make	:	
2.	Frame size	:	
3.	Applicable driven equipment	:	
4.	Horse Power	:	
4.1	Rating in KW for compressor/pumps	:	
4.2	BHP (KW) actually required by driven equipment under specified operating condition.	:	
5.	Rated voltage	:	
6.	Permissible voltage and frequency variation under normal running conditions.	:	
7.	Minimum voltage required under starting conditions to bring driven equipment up to rated speed.	:	
8.	No. of phase	:	
9.	Frequency (Hz)	:	
10.	Stator winding connection (Star or Delta)	:	
11.	At rated voltage and frequency	:	
11.1	Full load speed (rpm)	:	
11.2	Full load current (A)	:	
11.3	Starting current (percent of full load current)	:	
11.4	Starting torque (percent of full load torque)	:	
11.5	Pull-up torque (percent of full load torque)	:	
11.6	Breakdown torque (percent of full load torque)	:	
11.7	Efficiency	:	
	a) At full load	:	
	b) At half load	:	
	c) At 3/4 load	:	
11.8	Power factor	:	
	a) A full load	:	
	b) At half load	:	
	c) At 3/4 load	:	
	d) At start	:	
11.9	No load losses	:	
11.10	No load current	:	
11.11	Full load losses	:	
12.	Method of starting	:	
13.	Accelerating time in secs. (with full load	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

	connected)		
14.	Safe stall-time in secs.	:	
14.1	When motor is at rated operating temperature	:	
14.2	When motor is at ambient temperature.	:	
15.	Overload (percent of full load) that can be carried by motor without impairing overall performance and period for which this overload is applicable.	:	
16.	Stator thermal time constant.	:	
17.	Class of insulation	:	
18.	Temperature rise (°C) over ambient (State ambient applicable)	:	
18.1	By Thermometer	:	
18.2	By Winding Resistance	:	
19.	Shaft orientation	:	
20.	Method of connection to driven equipment	:	
21.	Direction of rotation and corresponding terminal designation	:	
22.	Enclosure and ventilation and reference standard:	:	
23.	Type of Bearing	:	
24.	Grounding device	:	
24.1	Method and number of ground points	:	
24.2	Location	:	
24.3	Cable for which grounding connector is suitable	:	
25.	Terminal box	:	
25.1	Type and number provided	:	
25.2	Whether phases segregated	:	
25.3	Recommended cable size	:	
26.	Critical speed (rpm)	:	
27.	Overspeed withstanding capacity	:	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

PART-II-G

TECHNICAL SPECIFICATION OF ELECTRICAL SYSTEM

1. SCOPE OF THE EPC CONTRACTOR

1.1. The EPC contractor shall be responsible for design, detailed engineering, supply, installation, testing & commissioning of one (1) No. 6.6kV, 3 phase Motor Control Centre (MCC) consisting of the following incoming & outgoing feeders:

- a) 2 nos. 6.6 kV, 630 A, Vacuum Circuit Breakers, suitable for a short circuit breaking capacity of 31.5 kA for 3 seconds – as incomers with suitable electrical & mechanical interlock between them.
- b) 5 nos. 6.6 kV 630A, Vacuum Circuit Breakers (VCB), suitable for a short circuit breaking capacity of 31.5 kA for 3 seconds – as outgoing feeders which shall feed 5 nos. 6.6 kV Variable Frequency Drives for Chiller compressors.

The MCC panel shall be complete with all necessary accessories viz. CTs, relays, indicating lamps, load manager etc. for efficient and trouble-free operation.

1.2. The EPC contractor shall be responsible for design, detailed engineering, supply, installation, testing & commissioning of one (1) No. 415 V, 3 phase Motor Control Centre (MCC) consisting of the following incoming & outgoing feeders:

- a) 2 nos. 415 V, 2500 A, 4 Pole, Air Circuit Breakers (ACB) with microprocessor-based releases for overload, short circuit & earth fault protections, suitable for a short circuit breaking capacity of 50 kA for 1 second – as incomers with suitable electrical & mechanical interlock between them.
- b) 5 nos. 415 V, 630A, TP-N, Moulded Case Circuit Breakers (MCCB) with microprocessor-based releases for overload & short circuit protections, suitable for a short circuit breaking capacity of 50 kA for 1 second – as outgoing feeders which shall feed 5 nos. 415V Variable Frequency Drives for Chiller water pumps.
- c) 5 nos. 415 V, 250A, TP-N, Moulded Case Circuit Breakers (MCCB) with microprocessor-based releases for overload & short circuit protections, suitable for a short circuit breaking capacity of 50 kA for 1 second – as outgoing feeders which shall feed 5 nos. 415V Variable Frequency Drives for Condenser cooling water pumps.
- d) 5 nos. 415 V, 63 A, TP-N, Moulded Case Circuit Breakers (MCCB) with thermal-magnetic based releases for overload & short circuit protections, suitable for a short circuit breaking capacity of 50 kA for 1 second – as outgoing feeders which shall feed 5 nos. 415V Variable Frequency Drives for Cooling tower fans.
- e) The MCC panel shall be complete with all necessary accessories viz. CTs, relays, indicating lamps, load manager etc. for efficient and trouble-free operation.

1.3. The EPC contractor shall prepare & submit the following documents/ drawings to BARC pertaining to MCC panels for approval before manufacturing:

- Detailed single line diagram.

<p>SPEC. NO.:</p> <p>NRB/128- CHW/INRP/2020</p>	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	<p>PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR</p>
---	---	---

- Detailed control wiring diagram.
- Detailed GA layout of the panels clearly showing the front, top & side views along with panel mounting arrangements and footprints.
- Guaranteed technical particulars (GTP).
- Bill of materials/ quantities (BOM/ BOQ).
- Quality assurance plan (QAP).

1.4. The EPC contractor shall be responsible for design, engineering, manufacture, assembly, testing, supply & delivery, properly packed for transport at site of 5 nos. 3 phase, 6.6 kV, Variable Frequency Drives (VFD) with schemes and interlocks as per requirement. The VFDs shall be complete with all materials and accessories necessary for efficient and trouble-free operation of 5 nos. 3 phase 6.6 kV, Chiller compressors (induction motors). The scope of work shall also include supervision for panel erection, termination of external cables, testing, commissioning, documentation and training of O&M personnel.

1.5. The EPC contractor shall be responsible for design, engineering, manufacture, assembly, testing, supply & delivery, properly packed for transport at site of 3 phase, 415V, Variable Frequency Drives (VFD) with schemes and interlocks as per requirement. The VFDs shall be complete with all materials and accessories necessary for efficient and trouble-free operation of:

- a) 5 nos. Chilled water pumps
- b) 5 nos. Condenser Cooling water pumps
- c) 5 nos. Cooling Tower fans

The scope of work shall also include supervision for panel erection, termination of external cables, testing, commissioning, documentation and training of O&M personnel.

1.6. The EPC contractor shall be responsible for design, detailed engineering, supply, laying, installation & testing of 6.35/11 kV(E) XLPE insulated power cables from 6.6 kV MCC panel in Chilled water plant to 6.6 kV Variable Frequency Drives (VFD) for Chiller compressors in the Chilled water plant. The 6.6 kV AC power supply shall be made available at site by BARC for energizing the 6.6 kV MCC panel. The termination of the cables to the 6.6 kV MCC panel and further distribution in the downstream to the VFDs and motors shall be carried out by the contractor. Inside the Chilled Water Plant, the cables shall be laid in underground trenches. Cabling from respective VFD drives to individual chiller compressors is also included in the scope of the contractor.

1.7. The EPC contractor shall be responsible for design, detailed engineering, supply, laying, installation & testing of 1.1 kV XLPE insulated power cables:

- a) From nearby 415V Power Control Center (PCC) in the Utility Block – 2 (Block 128) (50 m away from the Chilled water plant approximately) to the 415 V MCC located in

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

Chilled water plant. The cables shall be laid in underground trenches on ladder type GI cable trays.

b) From 415 V Motor Control Centre (MCC) in Chilled water plant to various 415 V VFD drives for pumps & fans of the Chilled water plant on ladder type GI cable trays in underground cable trenches. Cabling from respective VFD drives to individual pumps & fans is also included in the scope of the contractor.

1.8. The EPC contractor shall prepare & submit the following documents/ drawings to BARC pertaining to Cabling for approval before supplying:

- Cable sizing
- Cable schedule document.
- Cabling layouts.
- Bill of materials/ quantities (BOM/ BOQ) for complete cabling system.
- Quality assurance plan (QAP) for cables.

1.9. The EPC contractor shall be responsible for earthing of all electrical equipment viz. MCCs, cables, cable trays, motors, VFD panels etc. to the nearest earthing pads. The sizes of earthing conductors to be selected shall be as per Annexure-1. The earthing conductors for this purpose shall also be supplied by the contractor.

1.10. The EPC contractor shall be responsible for preparation of 'AS BUILT/ COMMISSIONED' drawings/ documents for the complete installation.

1.11. The EPC contractor shall be responsible for obtaining Electrical Inspector's and any other statutory clearances. This shall include approach to the concerned authorities with necessary technical literature, drawings & documents with application forms. The other expenses incurred in obtaining the approval shall be borne by EPC Contractor.

1.12. Civil works for underground trenches, manholes, motor foundations etc. is NOT included in the scope of the EPC contractor.

1.13. Earth pit outside the Chilled Water plant will be provided by NRB.

1.14. Typical Single line diagrams of 6.6 kV & 415V MCC panels and GA layout showing tentative locations of electrical panels are attached herein for reference.

2. SPECIFIC REQUIREMENTS OF MAJOR ELECTRICAL EQUIPMENT

2.1. 6.6 kV MOTOR CONTROL CENTRE (MCC)

2.1.1. MCC shall be single front, free standing, vertical, draw out type having hinged access doors with locking type latches and extensible at both the ends.

2.1.2. MCC shall be suitable for bottom cable entry.

2.1.3. MCC shall have IP 42 protection class.

<p>SPEC. NO.:</p> <p>NRB/128- CHW/INRP/2020</p>	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <hr/> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	<p>PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR</p>
---	---	---

- 2.1.4. MCC shall have sheet steel (cold rolled) thickness of 2.0 mm for load-bearing and 1.6 mm for non-load bearing members.
- 2.1.5. As the 6.6 kV input power supply at site is resistance earthed, the phase to phase & phase to earth insulation level of the panel shall be as per 11 kV, i.e. the panel shall be so designed so as to have a dielectric strength of insulation corresponding to an 11 kV MCC panel. The highest equipment voltage, lightning impulse withstand voltage and power frequency short duration withstand voltage shall have values 12 kV, 75 kV (peak) and 28 kV (rms) respectively for the panel (As per IS-2165).
- 2.1.6. A set of electrolytic grade Copper bus bars of continuous current rating of 630A shall run along the entire length of the switchgear. The bus bars shall be supported on insulators. Heat shrinkable PVC sleeved buses shall be supported on insulators which should be flame-retardant, track resistant, non-hygroscopic and have high impact strength. They shall be designed to withstand the electrical and mechanical stresses due to a fault having a prospective current of 31.5 kA rms for a period of 3 seconds. Bus bars shall be brazed to impart high impact strength. All the bus bar joints shall be suitably shrouded.
- 2.1.7. An earth bus shall be provided and extended throughout the length of the switchgear. The earth bus shall be made of electrolytic grade high purity tinned copper and shall have sufficient cross section to withstand a fault current of 31.5 kA for 1 second.
- 2.1.8. Operating height for MCC shall be restricted between 250 mm to 1800 mm from finished floor level.
- 2.1.9. MCC shall be epoxy powder coated having colour shade interior and exterior as pebble grey (shade RAL 7032 as per DIN standard).
- 2.1.10. MCC shall be 6.6 kV, 3 Phase, 50 Hz, suitable for a short circuit fault current of 31.5 kA for 3 seconds with Copper busbars having Vacuum Circuit Breakers (VCBs) as incoming & outgoing feeders.
- 2.1.11. Vacuum Circuit Breakers (VCBs) shall have following minimum features:
- a) The circuit breaker shall have motorized spring charging mechanism. The spring charging motor shall be suitable for 240V AC supply. The breaker shall be provided with hand-operated spring charging handle. Mechanical position indicator for SERVICE, TEST & ISOLATED status of breaker shall be provided. Manual close & open pushbuttons shall also be provided.
 - b) Earth switches shall be provided for earthing of bus bars during maintenance of the Vacuum Circuit Breakers. The earth switches shall be interlocked with the cable compartment cover.
 - c) The breaker shall have 3 nos. single phase Dual-core Potential Transformers (PTs) connected in star. The burden per transformer shall be not more than 50 VA and the voltage ratio shall be 6600/110 V. The accuracy class shall be Cl. 1.0 for Core-1 & Cl. 3P for Core-2. The PT shall be of epoxy-resin casted type construction and they shall conform to IS 3156.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- d) The breaker shall be fitted with shunt trip coil and closing coil suitable for 110V AC supply. The 110V AC supply shall be derived from PT.
- e) The breaker shall be provided with Current Transformers (CTs) (conforming to IS 2705) for metering and protection purposes. For metering CTs, the accuracy class shall be normally 1.0. The Protection CTs shall have class of accuracy of 5P20. The burden requirement of the CTs shall be 7.5 VA. The CT secondary shall be 5 A.
- f) The circuit breaker shall be fitted with numerical relays for instantaneous & delayed over current & earth fault protections. The numerical relays shall have following minimum features: -
- Minimum last five abnormal events recording (over current & earth fault) including fault level and phase along with date & time.
 - On-line display of current.
- g) The breaker's metering compartment shall consist of following components:
- Communicable type Load Manager.
 - Analog Ammeter (96 x 96 sq. mm) with Ammeter Selector Switch (ASS), CI-1.0.
 - Analog Voltmeter (96 x 96 sq. mm) with Voltmeter Selector Switch (VSS), CI-1.0.
- h) Minimum LED indications on front of each VCB shall be: ON, OFF, TRIP, Breaker EARTHED, SPRING CHARGED, Trip Circuit Healthy (TCH), Trip Relay Healthy (TRH), Control Supply failure & PIL.
- i) Padlocking facility shall be provided for circuit breakers and earthing switches.
- j) The Cable compartment of the circuit breaker shall be provided with suitable bushings for termination of incoming/ outgoing 6.35/11 kV (E), 3 core cables. The cable termination shall be done by Heat shrinkable termination method so that adequate clearances can be maintained between phases for termination. Cable termination boots shall be supplied by the switchgear manufacturer.
- 2.1.12. All control wiring shall be carried out by HFFR/ FRLS PVC wires.
- 2.1.13. Terminal block with 10% spare terminals shall be provided. Each terminal shall be suitable for terminating 2 x 2.5 sq. mm wires. The secondary terminals of the CTs & PTs shall be individually wired, using 2.5 sq.mm flexible copper wires (with color-coding and ferrules at both ends) up to a terminal block. The Terminal block shall be located, at a suitable height. The secondary of PTs shall be wired up to the terminal block. The CT secondary shall be covered with sealable covers.
- 2.1.14. The two incomers shall have suitable electrical as well as mechanical interlock such that only one of the incomers shall be in service at a time.
- 2.1.15. Spares & necessary accessories required for smooth operation of 6.6 kV MCC shall be supplied by the manufacturer and cost of the same may be included by the manufacturer in their total supply price. The following minimum spares must be provided along with other spares (recommended by the manufacturer):
- Current Transformer – 1 no.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Voltage Transformer – 1 no.
- HT Control Fuse – 3 nos.
- Shunt trip coil – 1 no.
- Closing coil – 1 no.

2.2. **415V MOTOR CONTROL CENTRE (MCC)**

2.2.1. MCCs shall be single front, free standing, vertical, fixed type having hinged access doors with locking type latches and extensible at both the ends.

2.2.2. MCC shall be suitable for bottom cable entry.

2.2.3. MCC shall have IP 52 protection class.

2.2.4. MCC shall have sheet steel (cold rolled) thickness of 2.0 mm for load-bearing and 1.6 mm for non-load bearing members.

2.2.5. MCC shall be provided with mains and earthing busbars of electrolytic grade copper.

2.2.6. Operating height for MCC shall be restricted between 250 mm to 1800mm from finished floor level.

2.2.7. MCC shall be epoxy powder coated having colour shade interior and exterior as pebble grey (shade RAL 7032 as per DIN standard).

2.2.8. MCC shall be 415V, 3 Phase, Neutral, 50 Hz, 50 kA for 1 sec. with copper busbars having Air Circuit Breaker (ACB) as incomer and Moulded Case Circuit Breakers (MCCBs) as outgoing feeders.

2.2.9. The Air Circuit Breakers (ACB) shall have following minimum features:

- a) Electrically operated fixed type with spring along with manual spring charging handle. The spring charging motor shall be suitable for 230 VAC supply.
- b) Microprocessor-based releases for O/L, S/C & E/F protections.
- c) Mechanical trip knob for actuation in emergency.
- d) Mechanical indication for SPRING CHARGED position.
- e) ON, OFF, TRIP & PIL LED type indications.
- f) Phase barriers between the poles.
- g) Trip reset facility.
- h) The operating mechanism shall be trip-free. Failure of spring, vibrations or shocks shall not cause unintended operation of breaker or prevent intended tripping operation. Closing of breakers shall be prevented unless the spring is fully charged.
- i) Shunt trip coil & Closing coil suitable for 230 VAC supply.
- j) All ACBs shall have short circuit breaking current capacity of 50 kA for 1 second.

2.2.10. The Moulded Case Circuit Breakers (MCCBs) shall have following minimum features:

- a) For an MCCB rating of 250A or above, the breaker shall have microprocessor-based releases for O/L & S/C protections.
- b) For an MCCB rating below 250A, the breaker shall have thermal-magnetic based releases for O/L & S/C protections.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- c) All MCCBs shall have short circuit breaking current capacity of 50 kA for 1 second.
 d) All MCCBs shall have a rotary type handle.
- 2.2.11. The panel shall be provided with Current Transformer (CTs) (conforming to IS 2705) for metering purposes in the incomer. The accuracy class shall be normally 1.0. The burden requirement of the CTs shall be 7.5 VA. The CT secondary shall be 5 A.
- 2.2.12. A set of electrolytic grade Copper busbars of rating 2500A shall run along the entire length of the switchgear. The bus bars shall be supported on insulators. Heat shrinkable PVC sleeved buses shall be supported on insulators which should be flame-retardant, track resistant, non-hygroscopic and have high impact strength. They shall be designed to withstand the electrical and mechanical stresses due to a fault having a prospective current of 50 kA rms for a minimum period of 1 second. Bus bars shall be brazed to impart high impact strength. All the bus bar joints shall be suitably shrouded.
- 2.2.13. An earth bus shall be provided and extended throughout the length of the switchgear. The earth bus shall be made of electrolytic grade high purity tinned copper and shall have sufficient cross section to withstand a fault current of 50 kA for 1 second.
- 2.2.14. Following meters shall be provided on incomer:
- Communicable type Load Manager.
 - Analog Ammeter (96 x 96 sq.mm) with Ammeter Selector Switch (ASS), CI-1.0.
 - Analog Voltmeter (96 x 96 sq.mm) with Voltmeter Selector Switch (VSS), CI-1.0.
- 2.2.15. Minimum LED indications on incomer ACBs shall be: ON, OFF, TRIP, SPRING CHARGED & PIL.
- 2.2.16. Minimum LED indications on outgoing MCCBs shall be: ON, OFF & TRIP.
- 2.2.17. Padlocking facility shall be provided for all circuit breakers.
- 2.2.18. All control wiring shall be carried out by HFFR/ FRLS PVC wires.
- 2.2.19. Terminal block with 10% spare terminals shall be provided. Each terminal shall be suitable for terminating 2 x 2.5 sq.mm wires. The secondary terminals of the CTs shall be individually wired, using 2.5 sq.mm flexible copper wires (with colour-coding and ferrules at both ends) up to a terminal block. The Terminal block shall be located, at a suitable height. The three phase voltages shall also be tapped from the LT Busbar and wired up to the terminal block. The CT secondary shall be covered with sealable covers.
- 2.2.20. The two incomers shall have suitable electrical as well as mechanical interlock such that only one of the incomers shall be in service at a time.
- 2.2.21. Spares & necessary accessories required for smooth operation of 415V MCC shall be supplied by the manufacturer and cost of the same may be included by the manufacturer in their total supply price. The following minimum spares must be provided along with other spares (recommended by the manufacturer):
- Current Transformer – 1 no.
 - LT Control Fuses – 3 nos.
 - Shunt trip coil – 1 no.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Closing coil – 1 no.

2.3. **6.6 kV VARIABLE FREQUENCY DRIVES (VFD)**

2.3.1. The starter system for the compressor motor shall form a part of chiller. Each chiller shall have its own starter system. It shall comprise of Variable Frequency Drives (VFDs).

2.3.2. The 6.6 kV Variable Frequency Drives, herein referred as VFD, shall be used to drive 6.6 kV Chiller compressors in Chilled Water Plant. The MV line circuit-breakers (VCBs) for the VFDs shall be housed in a separate 6.6 kV MCC panel located approximately 25 meters away from the 6.6 kV VFD room. Each VFD panel shall accommodate the input step-down transformer, AC drive, semi-conductor protection fuses etc.

2.3.3. The supplier's offer shall be in accordance with the minimum requirements mentioned herein. Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any extra charge.

2.3.4. The VFD shall be factory pre-wired, assembled and tested as a complete package (inverter + transformer) by the VFD supplier. For a customer specific drive, motor and application data should be pre-loaded into the operator interface and tested prior to shipment.

2.3.5. As the 6.6 kV input power supply at site is resistance earthed, the phase to phase & phase to earth insulation level of the VFD panel shall be designed with dielectric strength of insulation one level higher i.e. for 11 kV system (As per IS 2165).

2.3.6. **Power Supply Requirements**

a) **Input Voltage**

The drive shall accept nominal input voltage of 6.6 kV, 50Hz. The supply input voltage tolerance shall be $\pm 10\%$ of the nominal line voltage. The supply input frequency tolerance shall be $\pm 5\%$ of the nominal line frequency.

b) **Output Voltage**

Whatever the power supply voltage in the plant, the drive shall be able to supply 6.6kV induction motor.

c) **Auxiliary Voltage**

Auxiliaries (e.g. light, space heaters etc.) shall be supplied with 230V, single phase AC. 415V, 3 phase AC is available at site for external supply of auxiliaries like VFD cooling fan.

2.3.7. **Environmental Conditions**

a) The VFD shall be designed based on an ambient temperature of 45°C and with a relative humidity level of 90 %.

b) The climatic conditions are tropical and the atmosphere is laden with salt spray.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3.8. Standards Compliance

- a) All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable IS/ IEC standards (Annexure-2) except where modified and/ or supplemented by this specification.
- b) It shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS codes of practice. In addition, other rules or regulations applicable to the work shall be followed.

2.3.9. General Description

- a) The VFD panels shall be suitable for indoor use in non-air-conditioned switchgear room, totally enclosed, floor mounted and free standing.
- b) Design, material selection and workmanship shall be so as to present a neat appearance outside and inside with no welds, rivets, screws or bolt heads.
- c) The drive shall be of modular design to provide easy and fast maintenance. Metal barriers shall be provided between each vertical section and between the low voltage compartment and the power section. Personnel shall have access to the low voltage compartment, with the VFD energized, without being exposed to any high voltage.
- d) The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD shall be capable of operating with the rated current permanently or with disconnected motor at rated voltage.
- e) The VFD panel shall have lockable local & remote selector switch for operation either locally through panel or remote operation through PLC.
- f) The drive shall have Run Through feature in case supply fails for less than 100 ms. and shall have catch on fly option for smooth restart in case of loss of line supply or smooth power off, fault reset or automatic restart, Free wheel stop or injection stop with logic input and uncontrolled loss downstream of the drive.
- g) Schematic diagram, GA drawing of the panel, detailed engineering, selections of components must be approved by the purchaser prior to fabrication of the panel. This panel shall have following features:
 - Panel shall have cable entry facility either from top or bottom with gland plate cover.
 - Wires used in Panel shall be HFFR/ FRLS PVC insulated.
 - Motor & Drive fault shall be annunciated separately.
 - Panel shall have key lockable type local remote selector switch.
 - Pre-treatment of the panel shall follow 7-tank process and panel shall be powder coated with Siemens Grey (RAL 7032) shade.
 - Connectors used in control circuitry shall be of suitable size on DIN rail. Cables shall be soldered to lugs with single PVC printed tags.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Panel shall be well ventilated. It shall have sufficient cooling/ exhaust fans of appropriate rating. The VFD shall include temperature sensors to monitor proper operation of the cooling system.
- The minimum degree of protection of the VFD panel shall be IP: 31.
- Panel front features (minimum): ON, OFF, TRIP LED indicating lamps, Voltmeter, Motor current meter with true rms CT, Motor speed potentiometer, Start & Stop pushbuttons, L/R selector switch with key lockable type & Emergency stop.

2.3.10. **Impact of the VFD on network side**

- a) The supplier shall provide a constant power factor > 0.96 (from 20-100% speed). This performance shall be reached without any additional special device (reactor, capacitor).
- b) The supplier shall provide the adequate solution to minimize voltage & current harmonics in the supply side of VFD in compliance with IEEE 519 guidelines.
- c) The VFD must provide motor overload protection in any operating conditions. VFD output waveform shall be suitable for operating a squirrel-cage induction motor without de-rating or requiring additional service factor. To ensure that there are no problems with motor heating, VFD output current waveform shall be inherently sinusoidal between 10% and 100% speed regardless of the load.
- d) VFD's utilizing output step-up transformers are not acceptable.
- e) VFD shall inherently protect motor from high dv/dt stress (maximum accepted level 2100V/μs).
- f) An input transformer shall be included to provide common mode voltage protection and allow the use of a standard motor.

2.3.11. **Wave form on motor side**

The waveform on the motor side shall be in accordance to the voltage switching levels of VFD output. This voltage switching levels shall be lower than 1100V and the number of levels shall be in accordance with the required motor voltage. According to the selected number of switching inverter levels:

- a) The motor shall not be compromised thermally due to additional losses caused by PWM.
- b) dV/dt at the motor terminals shall be limited to 2100V/μs.
- c) All these performances shall be achieved without any additional device like reactors or filters etc.

The supplier shall provide data regarding:

- a) Harmonic spectrum.
- b) Maximum dV/dt.
- c) Maximum peak voltage according to motor and cable length.

2.3.12. **Reliability**

MTBF (mean time between failure) shall be minimum 50,000 hours.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3.13. **Efficiency**

VFD efficiency shall be better than 98 % (without transformer) and better than 96 % (with transformer) at 100% speed.

2.3.14. **Maintainability**

MTTR (mean time to repair) for inverter part shall not be more than 30 minutes.

2.3.15. **Overload capacity**

The VFD shall have a “normal duty” rating of 100% continuous current. According to the application, it shall be able to manage 120% overload for one minute, once every 10 minutes (Class 1 according IEC60146-1-1) and 150% overload for three seconds, once every 10 minutes.

2.3.16. **Motor control**

The VFD shall utilize V/f control and sensor less flux control and shall support closed loop vector control.

2.3.17. **VFD Control Unit & Interface**

The VFD Control unit shall be able to manage the following minimum functions:

- a) Speed control mode.
- b) Stall protection.
- c) Energy measurement.
- d) 1-year Trend recording.
- e) kWh counter with report (daily – weekly – monthly).
- f) Catch on the fly a spinning motor.
- g) Skip frequencies selection.
- h) Motor auto tuning function.
- i) Failure storage and history with actual values.
- j) Preset speeds setting.
- k) Ramp type setting and switching.
- l) Motor potentiometer/ speed raise/ lower function.

2.3.18. **Interface with the operator**

Control system shall be programmable by means of a minimum 6” LCD touch-panel display. By means of the touch screen, the following operations shall be done:

- a) Monitoring of actual values and parameters,
- b) Changing of parameter settings,
- c) Diagnostic and maintenance information,
- d) Exporting files for external usage.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

2.3.19. **Communication Interface with the automation system (PLC)**

The connection to the automation system shall be possible by means of digital communication.

Fieldbus Communication standard: Modbus TCP/IP over Ethernet.

2.3.20. **VFD Inputs/ Outputs Configuration**

VFD shall be provided with the minimum 4 DI, 3 DO, 2 AI & 2 AO.

2.3.21. **Protections and Fault Management**

- a) The drive shall have the following minimum protections for motor: Over load protection, Single Phasing & other standard protections, Protection against high dv/dt over voltages, protections against problems arising out of bearings and shaft induced currents.
- b) The drive shall have the following minimum protections for the Speed Controller: Short circuit, DC under voltage, DC over voltage, Earth fault, over load, over current, over temperature, stalling of motor, phase loss/ negative sequence.
- c) Doors of drive cubicles shall have handle locks. Doors of the Drive's MV section shall be secured by screws.
- d) VFD shall assume the following minimum protection and faults management as described in the table below:

Power transformer protections	Alarm + Trip	
Motor overload	Trip	
Motor over current	Trip	
Motor over temperature	Alarm + Trip	
Motor side ground fault	Alarm + Trip	Programmable
DC bus over voltage	Trip	
DC bus under voltage	Trip	with auto-reset
Inverter over temperature	Trip	
Cabinet high temperature	Alarm	
Single cooling fan fault	Alarm	

2.3.22. **Quality Assurance**

All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system, which must be registered to ISO 9001.

2.3.23. **Spares**

Mandatory spare parts and accessories required for smooth operation of MV drives shall be supplied by the manufacturer. The mandatory spares for each MV drive must include power cells (rectifier + DC link + inverter), which are required in case of failure of one or more power cells in MV drive.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3.24. **Warranty**

2.3.25. The guarantee / warranty shall cover for a period of 12 months from the date of satisfactory commissioning and handing over of the chilled water plant to the purchaser at site.

2.3.26. **Documentation**

AC drive supplier shall provide the below “as-built” documentation (1 no. soft copy + 2 nos. hard copies):

- a) Technical data sheets
- b) Layout/ arrangement drawings
- c) Single line diagrams, Wiring diagrams, Termination drawings
- d) Spare parts list
- e) Control schematics
- f) Bill of materials
- g) Programing manual, Operation and Maintenance manual, reports of tests and commissioning with protocols.
- h) Guarantee/ Warranty Card

2.3.27. **Inspection & Testing**

- a) VFDs shall conform in all respects, to the high standards of engineering, design and workmanship and shall be capable of performing in continuous operation, up to the supplier’s guarantee period, in a manner acceptable to the purchaser.
- b) As HT VFD for chiller will be provided by OEM with chiller so it will be tested during integrated testing of chiller & witnessed by purchaser’s representative.
- c) VFDs shall be type tested according IEC standards 61800-5-1. Type test reports shall be submitted to purchaser for review and approval.
- d) The supplier shall perform Acceptance and Routine Tests for all VFD panels as per relevant standards. Three copies (1 Soft copy + 2 hard copies) of test reports shall be submitted after testing of drives at manufacturer’s works. These test reports and available type test reports shall be submitted to the Purchaser before dispatch of the Drives.

2.3.28. **Packaging**

- a) VFD panels shall be protected for ocean shipment, inland transport, carriage at the site and outdoor storage in transit and at the site.
- b) Supplier shall be responsible for any damage to the above items during transit due to improper and inadequate packing.
- c) Only packages constructed out of suitable material and of dimensions proportional to the size and weight of contents shall be used.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- d) All items shall be protected for the entire period of dispatch, storage and erection, against corrosion, incidental damage, due to vermin, sun light, rain, high temperature, humid atmosphere, rough handling in transit and storage in open including delays in transit.

2.3.29. **Transport**

- a) No material shall be dispatched without prior consent of the purchaser or his representative.
- b) Supplier shall intimate in writing the probable date when the equipment shall be ready for dispatch at least within 10 days for foreign supply and five days for domestic supply in advance.

2.3.30. **Erection, Testing & Commissioning**

Complete erection, testing and commissioning of the supplied VFD panels shall be the responsibility of the EPC contractor. The VFD vendor shall perform the same under the supervision of the EPC contractor. The following shall be included during erection, testing & commissioning of VFDs:

- a) Necessary engineer supervision for erection work for proper execution and input/ output wiring connections including complete checking of materials at site and notifying & rectifying any discrepancy.
- b) Preparation of commissioning plan shall include
- Preparation of VFD manuals, power and control schematic.
 - Preparation of Input/ output interface drawing from panel to equipment, AC/DC source and VFD control signal from PLC, alarm/ trip signals to PLC etc.
 - Performing Protection settings.
 - Preparation of Secondary injection testing procedure and test formats for all protection functions.
- c) Arrangement of necessary testing kits.
- Multi-meter
 - Continuity tester
 - IR tester
 - Laptop with software for commissioning/ programming of VFD
 - Conveyance/ vehicle for testing kits

Boarding & lodging of deployed testing –commissioning engineer/ skilled/ unskilled manpower, skilled wireman etc. must be taken care of by the contractor/ vendor.

2.3.31. **Training**

- a) The vendor must depute an expert to give training to site operation & maintenance team.
- b) Extensive training to maintenance engineers at BARC site shall include:
- Understanding the VFD, control scheme and all components.
 - On using the VFD programming software.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- On programming/ configuring the VFD.
- On records viewing/ report generation.
- On trouble-shooting.

2.3.32. **415 V VARIABLE FREQUENCY DRIVES (VFDs)**

2.3.33. The 415 V Variable Frequency Drives, herein referred as VFD, shall drive the following pumps/ fans in the Chilled Water Plant:

- 5 nos. Chilled water pumps.
- 5 nos. Condenser Cooling water pumps.
- 5 nos. Cooling Tower fans.

2.3.34. The LV line circuit-breakers (ACBs/ MCCBs) for the VFDs shall be housed in a separate 415V MCC panel located near the 6.6 kV MCC panel in the Chilled Water Plant. Each VFD panel shall accommodate the drive, semi-conductor protection fuses, chokes or EMC filters etc. Rating of pumps/ fans shall be selected as per technical specification and approved design.

2.3.35. The supplier's offer shall be in accordance with the minimum requirements mentioned herein. Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble-free operation and maintenance of the equipment shall be furnished without any extra charge.

2.3.36. The VFD shall be factory pre-wired, assembled and tested as a complete package by the VFD supplier.

2.3.37. Power Supply Requirements

a) **Input Voltage**

The Drive shall accept nominal 3-phase, 415V AC, 50 Hz input voltage. The supply input voltage tolerance shall be $\pm 10\%$ of the nominal line voltage. The supply input frequency tolerance shall be $\pm 5\%$ of the nominal line frequency.

b) **Output Voltage**

The drive shall be able to supply 3-phase, 415V AC, 50Hz induction motor irrespective of the input voltage & frequency variations.

c) **Auxiliary Voltage**

Auxiliaries (e.g. light, space heaters etc.) shall be supplied with single phase 230V AC. 415 V 3 phase AC is available on site for external supply of auxiliaries like VFD cooling fan.

2.3.38. **Environmental Conditions**

- a) The VFD shall be designed based on an ambient temperature of 45 °C and with a relative humidity level of 90 %.
- b) The climatic conditions are tropical and the atmosphere is laden with salt spray.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3.39. **Standards Compliance**

- a) All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable IS/ IEC standards (Refer Annexure-2) except where modified and/ or supplemented by this specification.
- b) It shall meet the requirements of Indian Electricity Rules as amended up to date and relevant IS codes of practice. In addition, other rules or regulations applicable to the work shall be followed.

2.3.40. **General Description**

- a) The VFD panels shall be suitable for indoor use in non-air-conditioned switchgear room, totally enclosed, floor mounted and free standing.
- b) Design material selection and workmanship shall be so as to present a neat appearance outside and inside with no welds, rivets, screws or bolt heads.
- c) The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range. The VFD shall be capable of operating with the rated current permanently or with disconnected motor at rated voltage.
- d) The VFD panel shall have lockable local & remote selector switch for operation either locally through panel or remote operation through PLC.
- e) The drive shall have Run Through feature in case supply fails for less than 100 ms. and shall have catch on fly option for smooth restart in case of loss of line supply or smooth power off, fault reset or automatic restart, Free wheel stop or injection stop with logic input and uncontrolled loss downstream of the drive.
- f) Wired Panel for each drive shall be of suitable size for accommodating drive, semiconductor fuses and associated components viz. in-built EMC filter, AC choke etc. Schematic diagram, GA drawing of the panel, detailed engineering, selections of components must be approved by the purchaser prior to fabrication of the panel. This panel shall have following features:
 - Panel shall have cable entry facility either from top or bottom with gland plate cover.
 - Wires used in Panel shall be HFFR/ FRLS PVC insulated.
 - Motor & Drive fault shall be annunciated separately.
 - Panel shall have key lockable type local remote selector switch.
 - Pre-treatment of the panel shall follow 7-tank process and panel shall be powder coated with Siemens Grey (RAL 7032) shade.
 - Connectors used in control circuitry shall be of suitable size on DIN rail. Cables shall be soldered to lugs with single PVC printed tags.
 - Panel shall be well ventilated. It shall have sufficient cooling/ exhaust fans of appropriate rating. The VFD shall include temperature sensors to monitor proper operation of the cooling system.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- The degree of protection of the VFD panel shall be IP: 42.
- ON, OFF, TRIP LED indicating lamps, Voltmeter, Motor current meter with true rms CT, Motor speed potentiometer, Start & Stop pushbuttons, L/R selector switch with key lockable type & Emergency stop.

2.3.41. **Impact of the VFD on network side**

- a) The supplier shall provide the adequate solution to minimize voltage & current harmonics in the supply side of VFD in compliance with IEEE 519 guidelines.
- b) The power factor of the VFD in the input side shall be better than 0.96.

2.3.42. **Wave form on motor side**

- a) The VFD must provide motor overload protection in any operating conditions. VFD output waveform shall be suitable for operating a squirrel cage induction motor without de-rating or requiring additional service factor. To ensure that there are no problems with motor heating, VFD output current waveform shall be inherently sinusoidal between 10% and 100% speed regardless of the load.
- b) The VFD system shall inherently protect motor from high dv/dt stress, independent of cable length to the motor.

2.3.43. **Efficiency**

VFD efficiency shall be better than 97% at 100% speed.

2.3.44. **Overload capacity**

The VFD shall have a “normal duty” rating of 100% continuous current. According to the application, it shall be able to manage 120% overload for one minute, once every 10 minutes (Class 1 according IEC146-1-1) and 150% overload for three seconds, once every 10 minutes.

2.3.45. **Motor control**

The VFD shall utilize V/f control and sensor less flux control and shall support closed loop vector control.

2.3.46. **VFD Control Unit & Interface**

The VFD Control unit shall be able to manage the following minimum functions:

- a) Speed and torque control mode.
- b) Stall protection.
- c) Energy measurement.
- d) 1-year Trend recording.
- e) kWh counter with report (daily – weekly – monthly).
- f) Catch on the fly a spinning motor.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- g) Skip frequencies selection.
- h) Motor auto tuning function.
- i) Failure storage and history with actual values.
- j) Preset speeds setting.
- k) Ramp type setting and switching.
- l) Motor potentiometer (+/- speed) function.
- m) Parameter set switching.

2.3.47. **Interface with the operator**

Control system shall be programmable by means of a minimum 2-line LCD display (keypad). By means of the keypad, the following operations shall be done:

- a) Monitoring of actual values and parameters,
- b) Changing of parameter settings,
- c) Diagnostic and maintenance information,
- d) Exporting files for external usage.

2.3.48. **Communication Interface with the automation system (PLC)**

The connection to the automation system shall be possible by means of digital communication.

Fieldbus Communication standard: Modbus TCP/IP over Ethernet.

2.3.49. **VFD Inputs/ Outputs Configuration**

VFD shall be provided with the minimum 4 DI, 3 DO, 2 AI & 2 AO.

2.3.50. **VFD Protections and Fault Management**

- a) The drive shall have the following minimum protections for motor: Over load protection, Single Phasing & other standard protections, Protection against high dv/dt over voltages, protections against problems arising out of bearings and shaft induced currents.
- b) The drive shall have the following minimum protections for the Speed Controller: Short circuit, DC under voltage, DC over voltage, Earth fault, over load, over current, over temperature, stalling of motor, phase loss/ negative sequence.
- c) Doors of drive cubicles shall have handle locks.
- d) VFD shall assume protection and faults management as described in the table below:

Motor overload	Trip	
Motor over current	Trip	
Motor over temperature	Alarm + Trip	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Motor side ground fault	Alarm + Trip	Programmable
DC bus over voltage	Trip	
DC bus under voltage	Trip	with auto-reset
Inverter over temperature	Trip	
Cabinet high temperature	Alarm	
Single cooling fan fault	Alarm	

2.3.51. **Quality Assurance**

All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system, which must be registered to ISO 9001.

2.3.52. **Spares**

Mandatory spares required for smooth operation of LV drives shall be supplied by the manufacturer.

2.3.53. **Warranty**

The guarantee / warranty shall cover for a period of 12 months from the date of satisfactory commissioning and handing over of the chilled water plant to the purchaser at site.

2.3.54. **Documentation**

AC drive supplier shall provide the below "as-built" documentation (1 no. soft copy + 2 nos. hard copies):

- a) Technical data sheets.
- b) Layout/ arrangement drawings.
- c) Single line diagrams, Wiring diagrams, Termination drawings.
- d) Spare parts list.
- e) Control schematics.
- f) Bill of materials.
- g) Programming manual, Operation and Maintenance manual, reports of tests and commissioning with protocols.
- h) Guarantee/ Warranty Card.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.3.55. **Inspection & Testing**

- a) VFDs shall conform in all respects, to the high standards of engineering, design and workmanship and shall be capable of performing in continuous operation, up to the supplier's guarantee period, in a manner acceptable to the purchaser.
- b) The supplier shall notify the purchaser the date and location for the tests, giving sufficient time for the purchaser or his authorized representative to be present for LT VFD testing. The test procedure shall be got approved from the purchaser.
- c) VFDs shall be type tested according to IEC standards 61800-5-1. Type test report shall be submitted.
- d) The supplier shall perform Acceptance and Routine Tests for all VFD panels as per relevant standards. Three copies (1 Soft copy + 2 hard copies) of test reports shall be submitted after testing of drives at manufacturer's works. These test reports and available type test reports shall be submitted to the Purchaser before dispatch of the Drives.

2.3.56. **Packaging**

- a) VFD panels shall be protected for ocean shipment, inland transport, carriage at the site and outdoor storage transit and at the site.
- b) Supplier shall be responsible for any damage to the above items during transit due to improper and inadequate packing.
- c) Only packages constructed out of suitable material and of dimensions proportional to the size and weight of contents shall be used.
- d) All items shall be protected for the entire period of dispatch, storage and erection, against corrosion, incidental damage, due to vermin, sun light, rain, high temperature, humid atmosphere, rough handling in transit and storage in open including delays in transit.

2.3.57. **Transport**

- a) No material shall be dispatched without prior consent of the purchaser or his representative.
- b) Supplier shall intimate in writing the probable date when the equipment shall be ready for dispatch at least within 10 days for foreign supply and five days for domestic supply in advance.

2.3.58. **Erection, Testing & Commissioning**

Complete erection, testing and commissioning of the supplied VFD panels shall be the responsibility of the EPC contractor. The VFD vendor shall perform the same under the supervision of the EPC contractor. The following shall be included during erection, testing & commissioning of VFDs:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- a) Necessary engineer supervision for erection work for proper execution and input/ output wiring connections including complete checking of materials at site and notifying & rectifying any discrepancy.
- b) Preparation of commissioning plan shall include
 - Preparation of VFD manuals, power and control schematic.
 - Preparation of Input/ output interface drawing from panel to equipment, AC/DC source and VFD control signal from PLC, alarm/ trip signals to PLC etc.
 - Performing Protection settings.
 - Preparation of Secondary injection testing procedure and test formats for all protection functions.
- c) Arrangement of necessary testing kits.
 - Multi-meter
 - Continuity tester
 - IR tester
 - Laptop with software for commissioning/ programming of VFD
 - Conveyance/ vehicle for testing kits

Boarding & lodging of deployed testing–commissioning engineer/ skilled/ unskilled manpower, skilled wireman etc. must be taken care of by the contractor/ vendor.

2.3.59. **Training**

- a) The vendor must depute an expert to give training to site operation & maintenance team.
- b) Extensive training to maintenance engineers at BARC site shall include:
 - Understanding the VFD, control scheme and all components.
 - On using the VFD programming software.
 - On programming/ configuring the VFD.
 - On records viewing/ report generation.
 - On trouble-shooting.

2.4. **CABLING SYSTEM**

2.4.1. **Power Cables for 6.6 kV AC resistance earthed system**

- a) As the 6.6 kV input power supply at site is resistance earthed, 6.35/11 kV (E) Voltage Grade, 3 Core, stranded Aluminium conductor, XLPE insulated, extruded PVC inner sheathed, GI round wired armoured, extruded FRLS PVC outer sheathed cable suitable for 6.6 kV resistance earthed system as per latest IS 7098 (Part–2) shall be laid from main receiving substation (Block 132) to 6.6 kV MCC in Chilled Water Plant, Block 128.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- b) HV power cables shall be with stranded aluminum conductor, dry cured XLPE insulation, conductor & insulation screens, extruded PVC inner sheath, GI round wire armoured & extruded FRLS PVC outer sheath. The screen for the HV cables shall withstand earth fault current for one second.
- c) The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system earthing and short circuit withstand criteria. The derating due to ambient air temperature, ground temperature, grouping and distance of cables with each other etc., as applicable, shall be taken into account while calculating the size of cable.
- d) The cable sizing for HT & LT panels (MCCs) shall be carried out considering current rating and short circuit breaking capacity of incomer breaker.
- e) Cables shall generally be selected from standard cable sizes, current carrying capacities, and derating factors as available in vendor's catalogue.
- f) Following allowable voltage drops shall be considered for power cable sizing:
- Motor running condition:**
- i. Between transformer and switchgear and between switchgear and MCC: 2%
- ii. Between MCC and motors: 3%.
- Motor Starting condition:**
- i. Between transformer and motors during starting condition: 15%
- ii. Non-Motor Feeders: 5%
- g) The technical requirements of HT cable are as follows:

	<u>Requirement</u>
Voltage Grade (kV)	6.35/11 kV (E)
<u>Temperature Withstand capability</u>	
Maximum conductor temperature under normal operating condition	90 °C
Maximum conductor temperature at the time of short circuit condition	250 °C
<u>Variations in supply</u>	
Permissible voltage variation	± 10%
Permissible frequency variation	± 5%
<u>Conductor</u>	
Material	H4 grade Aluminium as per Class 2 of latest revision of IS: 8130.
Shape	Stranded compacted circular
<u>Conductor screening</u>	
Material	Extruded semi conducting compound
<u>Insulation</u>	

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

Material	XLPE as per latest revision of IS-7098 (Part-2)
Minimum thickness (mm)	3.6
<u>Insulation screening</u>	
<u>Non-metallic</u>	
Material	Extruded semi-conducting compound
<u>Metallic</u>	
Material	Copper tape
<u>Inner sheath</u>	
Material	Extruded PVC type ST-2 as per IS: 5831.
Minimum thickness (mm)	0.7
Color of inner sheath	Grey
<u>Armoring</u>	
Material	Galvanized steel
Type of armoring	Round wire
Nominal size armour (mm)	As per IS 7098 (Part-2, Table-4)
<u>Outer sheath</u>	
Material	FRLS PVC type ST-2 as per IS: 5831.
Minimum thickness (mm)	3
Colour of outer sheath	Black
Standards to which cable confirm	IS 8130, IS 7098 (Part 2), IS 5831, IS 3975 etc., with latest up to date amendments.
Conductor screening, XLPE insulation and insulation screening shall be carried out by	Triple extrusion process
Core identification	Red, yellow and blue
Laying up of cores with suitable right hand lay	Required

h) **Identification Marks**

- The cable shall be marked regularly at an interval of every 1 meter on the outer sheath. The manufacturer's name or trade mark indented, the size of the cable and voltage grading shall also be embossed at an interval of every one meter throughout the entire length.
- The cables to be supplied with the following details throughout the length of the cable by embossing on the outer sheath.

S. No.	Details to be Embossed on the outer sheath
1.	Name of manufacturer/ Trade Name
2.	Indian standard No. and Year
3.	Type of cable: XLPE

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

4.	Voltage grade: 6.35/11 kV (E)
5.	No. of cores: 3C
6.	Size in sq. mm: shall be worked out by the contractor during detailed engineering.
7.	User Name: INRP/NRB/BARC-T
8.	Year of manufacture:
9.	Sequential marking of running meter length (at every meter length)

- The running length of the cable shall be identified at regular intervals of not more than one meter (Increasing order from inner end to outer end of the cable).

i) Cable Drums

- Cables shall be supplied in specified and non-returnable steel drums. The cable drums shall comply in all respects as per IS: 10418. Cable drums shall be so constructed as to have required mechanical strength so that the drum flanges and other components do not break during transport, in actual use or in storage.
- The flanges and the outside surface of the barrel shall be free from protruding materials or projections or unevenness capable of damaging the cable or hands of operator during rotation of drums.
- A metal preservation shall be applied to the entire drum. All ferrous parts used shall be treated with a suitable rust free finish or coating to avoid rusting during transit or storage.
- After winding the cable on the cable drum, it shall be covered using High density black colour plastic covers so as to store it at site without any damage. The cable drum shall be covered using horizontal wooden planks throughout the outer periphery.

j) Packing and Marking

- The cable shall be wound on non-returnable steel drum of suitable size, packed and marked. The packing shall be such that it can withstand rough handling during transport and ensure that no damage shall be caused to the cable during transit.
- The markings done on the drums shall have the following information:
 - Reference of Indian Standards.
 - Manufacturer's name, brand name or trade mark.
 - Type of cable and voltage grade.
 - No. of cores.
 - Nominal cross-sectional area of the conductor.
 - Cable code.
 - Colour of cores (in case of multi-core cables).
 - Length of cable on the drum.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Number of lengths on drum (if more than one).
 - Direction of rotation of drum (by means or an arrow).
 - Approximate gross weight.
 - Country of manufacture.
 - Year of manufacture.
 - ISI certification mark.
 - Cumulative Length at every one meter interval.
 - Project Details- INRP/NRB/BARC-TARAPUR.
- The information shall be either stenciled on the drum or contained in a metallic label attached to it.
 - The outer ends of the cable shall be sealed by means of non-hygroscopic sealing materials, preferably by heat shrinkable end caps.
 - One end of the cable shall be brought out of the drum and suitably clamped to the drum flange with proper mechanical protection. Location of the other end may be marked on the drum.
 - The cable shall be placed on drums in such a manner that it shall be protected from damage during transit. Each end of the cable shall be firmly and properly secured to the drum. The drums shall be secured firmly in position so that they shall not shift during transit. No undue stress shall appear on cables when laid on drums.
 - A stainless-steel plate shall be securely fixed to each end of the drum indicating the contractor's purchase order number, length of cable, size of conductor, number of cores, type of cable and voltage grade. A tag containing the above said information shall be attached to the leading end of the cable inside the lagging.

2.4.2. Power Cables for 415V AC solidly earthed system

- a) All 415 V power cables shall be 650/ 1100 V grade, 90 °C continuous normal rating (250°C short circuit rating) with stranded and compacted high conductivity copper/aluminum conductor, extruded XLPE insulated, colour coded, extruded PVC inner sheathed for multi-core cable (no inner sheath for single core cable), GI round wire armoured and extruded FRLS PVC overall outer sheathed conforming to IS 7098, Part-1.
- b) LT power cable with copper conductor shall be considered for cable size upto and including 50 sq. mm whereas for cable sizes above 50 sq. mm, aluminium conductor shall be considered.
- c) The cables shall be sized based on the maximum continuous load current, the voltage drop, system voltage, system earthing and short circuit withstand criteria. The derating due to ambient air temperature, ground temperature, grouping and distance of cable with each other etc., as applicable, shall be taken into account while calculating the size of cable.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- d) Cables shall generally be selected from standard cable sizes, current carrying capacities and derating factors as available in vendor's catalogue.
- e) Following allowable voltage drops shall be considered for power cable sizing:
- i. Motor running condition:
 - a) Between transformer and switchgear and between switchgear and MCC: 2%
 - b) Between MCC and motors: 3%.
 - ii. Motor Starting condition:
 - a) Between transformer and motors during starting condition: 15%
 - b) Non-Motor Feeders: 5%
- f) The minimum conductor size for LT power cable shall be 2.5 sq.mm Copper.
- g) The technical requirements of LT cable are as follows:

Type of cable	- 2XWY/ A2XWY.
Voltage grade	- 1.1 kV grade
Suitable for earthed/unearthed system	- Earthed system.
Number of cores	- 3 ½ Core.
Conductor material, purity and grade	- Copper/Aluminium, Electrolytic grade of 99.9% purity.
Whether conductor is multi stranded as per class 5	- Yes.
Insulation	- XLPE.
Material of Inner sheath	- PVC (ST-2)
Material of Outer sheath	- FRLS PVC (ST-2)
Material and type of armour	- GI wire armour.
Type of Drum	- Steel drums.

2.4.3. **Control Cables**

- a) Control cables shall be 650/1100 V grade, 70 °C continuous normal rating (160°C short circuit rating), multi core with stranded and circular high conductivity annealed plain copper conductor, extruded PVC (Type A) insulated, colour coded, extruded PVC (ST-1) inner sheathed, GI round wire armoured and extruded FRLS PVC (ST-1) overall outer sheathed conforming to IS 1554, Part-1.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- b) The control cables shall be 1.5 mm² copper conductor. Multicore/ Multipair control cable shall have minimum 20% spare cores.
- c) Screened control cables shall be used for all VFD drive applications.
- 2.4.4. **Cable Laying**
- a) Cables shall be laid in underground RCC trenches. Tentative GA layout shall be referred for location of trenches.
- b) The highest voltage grade cables shall be laid in the topmost tray and other voltage grade cables in the lower trays in descending order of voltage. The order of cable laying starting from top of the tray is given below:
- HT (6.6kV) power cables;
 - 415 V AC power cables;
 - Control cables;
 - Instrumentation & signal cables.
- c) HT cables laid on tray, in trench or in open air shall be in single layer formation.
- d) LT power cables laid on tray, in trench or in open air shall be laid in multi layers touching each other keeping 30% spare space.
- 2.4.5. All control cables and instrumentation cables shall be laid in multi layers touching each other in their respective trays.
- 2.4.6. **Cable Trays**
- a) Power cables shall be laid in GI ladder type trays, whereas control cables shall be laid in GI perforated trays. Power and control cables shall be laid in separate trays.
- b) Cable trays and fittings shall be constructed from minimum 14 SWG sheet steel and hot dip galvanized after fabrication.
- c) Ladder type cable tray rungs shall be at an interval of 250 mm and cable trays shall be supported at an interval of 1500 mm.
- d) Vertical distance between adjacent cable trays, measured from the bottom of the upper tray to the bottom of the lower tray, shall be 300 mm.
- e) Maximum loading on the tray shall be such as to keep the bending stress within permissible limit with minimum factor of safety of 1.5.
- f) Ladder type cable trays generally shall be of 750, 600, 450, 300 or 150 mm width, whereas perforated type trays shall be of 600, 450, 300 or 150 mm width. Each cable tray length shall be limited to 2.5 meter with rung spacing of 250 mm. Two straight trays shall be coupled with a coupler plate made of 2 mm thick MS sheet.
- g) Cable tray supports shall be fabricated from standard MS angles/ channels/ flats depending upon site conditions. The trays shall be bolted to cable tray support structure using suitable clamps etc.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.4.7. **Cable Terminations**

- a) Heat shrinkable type end termination kits shall be used for HT & LT cables.
- b) Double compression type cable glands shall be used for both HT & LT cables. Cable glands shall be brass casting, machine finished and tinned to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.
- c) Cable lugs shall be of bimetallic, solder less crimping type. The current rating of the lugs shall be same as that of the respective cable conductors.

2.4.8. **Fire Proof Sealing System**

- a) Fire barriers/ fire stops and fire breaks shall be considered along the length of cables in cable trenches to prevent spread of fire from one area to other.
- b) At the penetration through walls, floors and ceiling forming the boundary of a fire cell, the fire seal to be installed should be penetrated only by the electrical cable and not by the supporting cable tray.
- c) Fire barriers/fire stops shall be rated for 3 hour fire rating as per IS-12458-1988. Fire stops shall be provided at the openings in walls when cables cross from one building to other and openings in floor when cable trays cross from one floor to other (On both sides of wall and floor).
- d) Fire protection coating shall be provided at every 30 meters length in a cable trench/tunnel for 1meter length.

2.5. **EARTHING SYSTEM**

Taps from main earthing grid and/ or earthing pad provided near the equipment/ structure shall be connected to earthing terminals of the equipment/ structure at two distinct points. The size of earthing leads shall be chosen as per Annexure-1. All the equipment in the plant shall be effectively earthed for personnel safety as follows:

2.5.1. **Cables**

Armour of three core cables shall be earthed at both ends using double compression gland. 25mm x 6mm GI earthing strip shall be run along the cable tray and shall be connected to main earthing grid at 25 m interval at minimum two points.

2.5.2. **Cable Trays**

GI Earthing strip of size 25 x 6mm shall be laid along one tier of cable tray and consecutive tiers of trays shall be interconnected with it at every 25m interval. These strips inturn shall be connected to main earthing grid at minimum two points through 70sq.mm earthing tails at every 25m interval. Also, interconnection of each cable tray with adjacent cable tray shall be carried outthrough 10sq.mm flexible jumpers.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

2.5.3. **Motors**

Frames of all electric motors shall be connected to the earthing system by two distinct paths.

2.5.4. **Electrical panels**

Internal earthing bus of each electrical panel (MCCs/ VFDs) shall be connected at both ends to the nearest earthing pad or tail by means of electrolytic grade copper conductor/ strip of suitable size (As per Annexure-1).

2.5.5. **Miscellaneous Steel Structures**

All steel structures accessible to personnel such as enclosures, steel stairways etc. shall be connected to earthing system.

2.5.6. **Connections**

All connections in the equipment earth conductors buried in ground shall be welded/brazed, whereas connection at equipment end shall be of bolted type. All connections shall be of low resistance. Contact resistance shall also be minimum. All bimetallic connection shall be treated with suitable compound to prevent moisture ingress. For Bimetallic bolted connection, bimetallic washers shall be used.

3. SAFETY EQUIPMENT

- 3.1. Hand gloves, 6.6/ 1.1 kV grade electrical insulating mats as per latest IS, Danger caution boards, Chart for Restoration from shock and First aid box shall be provided.

4. INSTALLATION / ERECTION WORK

- 4.1. Construction supply at 415V shall be made available by BARC at one point. However, further distribution shall be done by EPC Contractor.
- 4.2. The EPC Contractor shall possess valid electrical license of appropriate class from the concerned statutory authorities governing the area of work place. The EPC Contractor shall fully comply with the relevant statutory rules and regulations.
- 4.3. All site test reports in a specified format maintained by EPC Contractor, duly approved by NRB, BARC, shall be handed over to BARC after completion of job.
- 4.4. All hardware i.e. screws, bolts, fasteners, for all equipment shall be of G.I./ Cadmium plated.
- 4.5. EPC Contractor is required to submit the list of sub-vendors for the equipment to be supplied and shall match the same with list of approved sub-vendors. This list shall be subject to approval of NRB, BARC.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

5. STANDARDS COMPLIANCE

- 5.1. The equipment shall comply in all respects with the requirements of the latest editions of the codes and standards specified in Annexure-2. Other National Standards are acceptable if, they are established to be equal or superior to the listed standards.
- 5.2. Testing, installation, and commissioning shall comply with the requirement of latest editions of Indian Standards and Codes of Practices.
- 5.3. EPC Contractor shall ensure use of calibrated test equipment having valid calibrated test certificates traceable to national standard. All equipment and material supplied by EPC Contractor for installation and commissioning purpose shall meet the requirements of Indian Standard, and Tariff Advisory Committee's (TAC) regulations (fire insurance) and Electrical Inspectorate. The installation shall be in line with latest Indian Electricity Rules.

6. TESTING AND COMMISSIONING

- 6.1. Acceptance and routine tests for all supply equipment/component parts shall be carried out as per the relevant standards for the respective equipment. These test reports and manufacturer's type test reports shall be submitted to NRB, BARC before dispatch of the equipment.
- 6.2. All testing instruments required for carrying out acceptance tests at site is included in the scope of the EPC contractor.
- 6.3. All test equipment shall have valid calibration certificates and shall be made available at the time of inspection. EPC Contractor shall arrange dispatch of inspected equipment after obtaining dispatch clearance from NRB, BARC.
- 6.4. The check and commissioning tests at site shall be carried out as per Annexure-4. It is the responsibility of EPC Contractor to arrange for required test equipment for such purpose.
- 6.5. NRB, BARC may ask for such additional tests on site, as in their opinion, are necessary to determine that the work comply with the specifications or IS code of installation. EPC Contractor shall be responsible and bear the cost of such additional tests.
- 6.6. Typical type test certificate for all equipment of equivalent ratings shall be submitted for scrutiny/approval by NRB, BARC.
- 6.7. All pre-commissioning tests shall be carried out in the presence of NRB, BARC representative and approval for the same shall be obtained before the plant commissioning.
- 6.8. Getting Electrical Inspector's clearance and any other statutory clearance shall be entirely the responsibility of EPC Contractor.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

6.9. Prices quoted shall include the cost of all routine tests specified in Annexure-3. As regards type tests, copies of the earlier test certificates carried out on equipment of similar ratings shall be furnished.

7. DOCUMENTATION

7.1. EPC Contractor shall furnish detailed inter-panel wiring diagrams, terminal connection wiring diagram, detailed component layout drawings and installation, operation and maintenance manuals to enable BARC to carry out maintenance work.

8. DRAWINGS

8.1. The drawings enclosed forms part of this package. These drawings are indicative and for general guidance of EPC Contractor. NRB, BARC may also issue further drawings and sketches, if considered necessary for execution of the work. The responsibility of executing work as per detailed drawings, submission to Electrical Inspectorate and Statutory authorities, obtaining approval, arranging for inspection and rectifying defects as pointed out, provision of any additional items, wherever necessary, to satisfy statutory authorities and Electrical Inspectorate rests with EPC Contractor.

9. INFORMATION TO BE SUBMITTED WITH THE BID

9.1. EPC Contractor shall furnish the makes and technical datasheets of all the electrical equipment viz. MCCs, VFDs, Cables and Cable trays, Earthing conductors etc. The make shall be reputed.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE-1

EQUIPMENT EARTHING CONDUTOR SIZES

Sr. No.	Leads to Equipment/ Structures	Material	Size	No. of Leads	Remarks
1.	Switchgear Panels (MCCs/ VFDs)	Copper	2 x 95 mm ²	2	-
2.	Motors				
2.1	Up to 7.4 kW	Copper	10mm ²	2	
2.2	7.5 kW to 19 kW	Copper	35 mm ²	2	
2.3	20 kW to 74 kW	Copper	70mm ²	2	
2.4	75 kW and above	Copper	125 mm ²	2	
3.	Cable Trays				
3.1	Connection to main grid	Copper	70 mm ²	2	Minimum 2 and further at every 25 m interval.
3.2	Along the cable tray and interconnection of trays	GS	25 x 6 mm	1	At interval of 25 m.
4.	Metallic non-current carrying structures, tanks and ventilation ducts	GS	25 x 6 mm	1	-

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE-2

APPLICABLE CODES & STANDARDS

<u>HV SWITCHGEAR</u>	
IEC: 62271- 200	High-voltage switchgear and control gear - Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.
IEC:62271 - 100	High-voltage switchgear and control gear - Part 100: Alternating-current circuit-breakers.
IS: 13118	Specification for High Voltage Alternating Current Circuit Breakers.
IS: 8130	Specification for conductors for insulated electric cables and flexible cords.
IS: 3427	A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and up to and including 52 kV.
IS: 2705 IEC:61869-1	Current Transformers.
IS: 3156 IEC: 61869-3	Voltage Transformers.
IS: 1248 IEC:60051	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories.
IS: 3231	Specification for electrical relays for power system protection.
IS: 9385	High Voltage Fuses.
IS: 13703	Specification for Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS: 6005	Code of practice for phosphate coatings of iron and steel.
IS: 2165 (Part 1 & 2)	Insulation Coordination.
IS: 3716	Application guide for Insulation Coordination.
<u>LV SWITCHGEAR</u>	
IEC 61439	Low-voltage switchgear & control gear assemblies.
IS 13703	Specification for Low voltage fuses for voltages not exceeding 1000V AC or 1500V DC.
IS/IEC60947 (Part 1 to 5)	Low Voltage Switchgear and control gear.
IS-2705 (Parts 1 to 3)	Current transformers - Specification.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

IS 3156 (Parts 1 to 3)	Voltage transformers - Specification.
IS 3231	Specification for electrical relays for power system protection.
IS 1248	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories.
IS 1554 - 1	Specification for PVC insulated (Heavy duty) electric cables – Part 1: For working voltages up to and including 1100V.
IS 694	Polyvinyl Chloride insulated unsheathed and sheathed cables/ cords with rigid and flexible Conductor for rated voltages up to and including 450/ 750 V.
IS 513	Cold reduced low carbon steel sheet and strip.
IS 6005	Code of practice for phosphate coatings of iron and steel.
IS 5	Colours for Ready Mixed Paints and Enamels.
IS 5082	Wrought aluminium and aluminium alloy bars, rods, tubes and sections for electrical purposes.

VARIABLE FREQUENCY DRIVES

IEC 61800 - 1	Adjustable Speed Electrical Power Drive Systems - Part 1: General Requirements - Rating Specifications for Low Voltage Adjustable Speed d.c. Power Drive Systems.
IEC 61800 - 2	Adjustable speed electrical power drive systems - Part 2: General requirements - Rating specifications for low voltage adjustable speed a.c. power drive systems.
IEC 61800 - 3	Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods.
IEC 61800 - 4	Adjustable speed electrical power drive systems - Part 4: General requirements - Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV.
IEC 61800 - 5	Adjustable speed electrical power drive systems - Part 5: Safety requirements.
IEC 60146 - 1	Semiconductor converters –Part 1: General requirements and line commutated converters.
IEC 60204 - 1	Safety of machinery - Electrical equipment of machines – Part 1: General requirements.
IEC 60204 - 11	Safety of machinery - Electrical equipment of machines – Part 11: Requirements for equipment for voltages above 1000VAC or 1500VDC and not exceeding 36 kV.
IEC 60529	Degree of protections provided by enclosures (IP code).

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

IEC 61378-1	Converter transformers– Part 1: Transformers for industrial applications.
IEC 60076	Power Transformers.
<u>CABLING SYSTEM</u>	
IEC 60502-2	Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV - Part 2: Cables for rated voltages from 6 kV up to 30 kV.
IS 7098-1	Cross-linked polyethylene insulated PVC sheathed cables - Part 1: For working voltage up to and including 1100 V.
IS 3975	Low carbon galvanized steel wires, formed wires and tapes for armouring of cables - Specification.
IS 10810	Method of tests for cables.
IS 5831	Specification for PVC insulation and sheath of electric cables.
IS 8130	Specification for conductors for insulated electric cables and flexible cords.
IS: 2629	Recommended practice for Hot dip galvanizing of iron & steel.
IS: 4759	Hot-dip zinc coatings on structural steel and other allied products - Specifications.
IS: 10418	Drums for electric cables.
ISO-9001	Quality management systems – Requirements.
IS: 8309	Compression type tubular terminal ends for aluminium conductors of insulated cables - Specification.
IS: 12943	Brass glands for PVC cables - Specification.
<u>FIRE SAFETY</u>	
IS 12459	Code of practice for fire safety in cable runs.
IEC 60332	Tests on electric and optical fibre cables under fire conditions.
IS 10810-53	Method of tests for cables – Flammability test.
<u>EQUIPMENT EARTHING</u>	
IS 3043	Code of practice for Earthing.
IS:2927	Specification for Brazing alloys.
IEEE-80	IEEE guide for safety in AC substation grounding.
<u>EQUIPMENT INSTALLATION & MAINTENANCE</u>	
IS: 10118	Code of practice for Selection, Installation and maintenance of switchgear & control gear.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

BS: 6423	Code of practice for maintenance of low-voltage switchgear and control gear.
IS: 5216 (Parts 1& 2)	Recommendations on safety procedures and practices in electrical work.
IS: 2629	Recommended practice for Hot dip galvanizing of iron & steel.
IS: 1646	Code of practice for Fire safety of buildings (General) – Electrical installations.
IS: 2551	Danger notice plates.
IS: 1255	Code of practice for installation and maintenance of power cables up to and including 33 kV rating.
	Indian Electricity Act – 2003 (as amended up to date).
	Indian Electricity Rules, 2005 (as amended up to date).

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <hr/> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

ANNEXURE-3

TESTS & TEST REPORTS

1. 6.6 kV & 415 V MOTOR CONTROL CENTRES (MCCs)

a) Routine Tests (to be conducted on 6.6 kV MCC & 415 V MCC panels in presence of Purchaser's representative at manufacturer's works)

- Verification of dimensions and visual inspection.
- Physical verification of bill of materials.
- Mechanical operation tests.
- Power frequency voltages withstand tests on the main circuit.
- Voltages withstand tests on control and auxiliary circuits.
- Measurement of the resistance of the main circuit.
- Continuity & polarity tests on all coils and circuits.
- Inspection of painting and thickness thereof. It should not be less than 70 microns.
- Certificates on Circuit-breakers, switches and other major components shall be submitted.
- Calibration Certificates of Relays and Meters shall be submitted.

b) Site Acceptance Tests (to be conducted at site in presence of Purchaser's representative on 6.6 kV MCC & 415 V MCC panels)

- High Voltage Test.
- Insulation Resistance Test.
- Milli Volt Drop Test.
- Functional Test.
- Calibration of Relays and meters.
- Door interlock logic.

c) Type Test Reports (conducted on 6.6 kV & 415 V MCC panels of similar design) to be submitted to Purchaser

- Temperature rise test.
- Short circuit test.
- Degree of Protection test.

2. VARIABLE FREQUENCY DRIVES (VFDs)

- a) The following minimum tests shall be conducted on each of the VFD panels at manufacturer's works in addition to all the tests required by IEC standards and

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

manufacturer's standard established practices (as agreed between customer and supplier).

- Visual & Dimensional checks.
 - Physical verification of bill of materials.
 - Checking of speed /rpm at different frequencies.
 - Insulation Test.
 - Light Load test.
 - Functional tests.
 - Checking of Auxiliary Devices.
 - High voltage test.
 - Automatic restart/re-acceleration test.
 - Checking of Noise Level.
 - Power quality analysis and CT meter testing by current injection method.
- b) VFDs shall be type tested according to IEC standards 61800-5-1. Type test reports shall be submitted to Purchaser on request.

3. **6.35/ 11 kV (E) CABLES**

a) **Factory Acceptance Tests (to be conducted on a representative sample from the delivery lot at manufacturer's works as per IS: 7098 (Part-2))**

- Tensile test for aluminium.
- Wrapping test for aluminium.
- Insulation resistance test.
- High voltage test.
- Test for thickness of insulation and sheath.
- Hot set test for insulation.
- Tensile strength and elongation at break test for insulation and sheath.
- Partial discharge test (on full drum length).
- Conductor Resistance tests.
- Water tightness test in longitudinal directions.

b) **Routine Tests (to be carried out on each and every length of cable at manufacturer's works)**

- Resistance test for conductors.
- Insulation resistance (Dry) test.
- High voltage test.
- Partial discharge test.

c) **Site Acceptance Tests (to be conducted at site in presence of Purchaser's representative)**

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Insulation Resistance test.
 - Continuity test.
- d) **Type Test Reports (conducted on same rating of cable) to be submitted to Purchaser**
- Tensile test for aluminium.
 - Wrapping test for aluminium.
 - Insulation resistance test.
 - High voltage test.
 - Test for thickness of insulation and sheath.
 - Hot set test for insulation.
 - Tensile strength and elongation at break test for insulation and sheath.
 - Partial discharge test
 - Conductor Resistance tests.
 - Tests for armouring wires.
 - Bending test.
 - Dielectric power factor test.
 - Heating cycle test.
 - Impulse withstand test.
 - Flammability test.
 - Water tightness test in longitudinal direction.

4. **1.1 kV CABLES**

- a) **Routine Tests (to be carried out on each and every length of cable at manufacturer's works)**
- Resistance test for aluminum.
 - High voltage test.
- b) **Factory Acceptance Tests (to carried out on samples taken out from the production lot at manufacturer's works)**
- Tensile test for aluminum.
 - Wrapping test for aluminum
 - Resistance test for aluminum conductor.
 - Test for thickness of insulation and sheath.
 - Physical test for insulation and sheath.
 - Fire resistance test.
 - Insulation resistance test.
 - High voltage test (water immersion test).
 - Tests on armor wires.
- c) **FRLS Tests (to be conducted at Manufacturer's works)**

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- Critical Oxygen index as per ASDM-D 2863
- Temperature index as per ASTM-D 2863 & BICC Handbook Ch. No.6
- Smoke Density (Light Transmission) as per ASTM –D 2843
- Acid gas generation as per IEC 754-1
- Flammability tests as per IEC 332-1 and IS 694:1990

d) **Acceptance Tests (to be conducted at site in presence of Purchaser’s representative)**

- Insulation Resistance test.
- Continuity test.

5. EQUIPMENT EARTHING

a) **Site Acceptance Tests (to be conducted in presence of Purchaser’s representative)**

- Earth resistance test.
- Earth continuity test.

SPEC. NO.: NRB/128- CHW/INRP/2020	<p style="text-align: center;">NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE</p> <p style="text-align: center;">TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT</p>	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	---	--

ANNEXURE-4

COMMISSIONING CHECKLIST FOR ELECTRICAL EQUIPMENT

COMMISSIONING CHECKLIST FOR SWITCHGEARS

- ✓ Name plate details
- ✓ Make
- ✓ Rating of Busbars
- ✓ Voltage
- ✓ Frequency
- ✓ Main busbars (No. & sizes)
- ✓ Number and type of Incomer
- ✓ Number and type of outgoing feeders

Preliminary Checks

- ✓ Check for physical damage.
- ✓ Check tightness of all bolts, clamps and connecting terminals for both power and control circuits.
- ✓ Check cleanliness.
- ✓ Check tightness of earthing connections at two distinct points.
- ✓ Whether breaker can be inserted properly.
- ✓ Tightness of busbar joints to be checked.
- ✓ Breaker contacts should be fixed tightly with fixed contacts.
- ✓ Presence of fire extinguisher in the room.
- ✓ Panel space heater to be kept on when the panel is not energized.
- ✓ Check the presence of 'DANGER' notice board on the panel.
- ✓ Check busbar clearances and creepage distances to earth.
- ✓ Tests for external wiring/cabling and inter-panel connection.

Commissioning Checks

- ✓ Continuity tests for wiring, cabling, individual components.
- ✓ Insulation resistance (IR) values between phase to phase and phase to neutral and phase/neutral busbars to Earth.
- ✓ Phase sequence test for incomer.
- ✓ Milli voltage drop test on busbar joints of main and neutral busbars from one panel to another.
- ✓ Mechanical operation of MCCBs (incomer/outgoing feeders).
- ✓ Functional tests of control circuit, space heater, indication circuit, MCB, timer etc.
- ✓ Calibration of ammeters/ voltmeters.
- ✓ IR tests for control circuit; phase to earth.
- ✓ Resistance, polarity, ratio tests and IR measurements for current transformers.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

- ✓ IR test for external cable connections.
- ✓ Current injection tests for CTs.
- ✓ Checks on power cable termination or busduct termination.

COMMISSIONING CHECKLIST FOR CABLES

Preliminary Checks

- ✓ Check that parameters are as per specification.
- ✓ Check for physical damage.
- ✓ Ensure that gland plates of single core power cables are of non-magnetic material.
- ✓ Inhibiting compounds are used for crimping lugs.
- ✓ Bimetallic lugs are used when connections are made between different materials (i.e. Cu and Al).

Commissioning Checklist

- ✓ Insulation resistance (IR) test between each core and armour/sheath.
- ✓ Continuity check.
- ✓ Check connections.
- ✓ Armour of single core cables should be earthed at one end only and for multi-core cables, they are earthed at both ends.
- ✓ Tagging of cables, ferrules of wires are done as per cable schedule.
- ✓ Check for phase marking/ colour coding at both ends.
- ✓ Check for earthing of armour at source and load ends.
- ✓ Check for cable fire breaks/ barriers.

COMMISSIONING CHECK LIST FOR ELECTRICAL INSTALLATION (GENERAL)

- ✓ Check earth clearance/section clearance of electrical conductors.
- ✓ Check accidental contact with exposed electrical conductors are prevented by means of enclosure, fence, wire mesh etc.
- ✓ Danger boards are displayed at all electrical installations.
- ✓ Test the fire detection system, if provided.
- ✓ All 415V and 230V power cables should be meggered and IR value noted for reference.
- ✓ Functional Checking
 - Check all closing, tripping, supervision and interlock of control devices.
 - Check operation of all alarm circuits.
- ✓ Check operation of protective relays/ relay coordination.

In addition to the above, any other tests, as specified by manufacturer of equipment shall be carried out as per manufacturer's instructions.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

PART-II-H

TECHNICAL SPECIFICATIONS FOR INSTRUMENTATION & CONTROL SYSTEM

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

INSTRUMENTATION AND CONTROL FOR CHILLED WATER PLANT

1 INSTRUMENTATION & CONTROL SYSTEM:

- 1.1 Reliable, industrial, scalable Programmable Logic Controller (PLC) – Human Machine Interface (HMI) and intelligent Supervisory Control And Data Acquisition (SCADA) based system with suitable number of I/Os shall be provided to monitor, control & operate chilled water plant.
- 1.2 Selection of PLC and associated sensors & control components shall be industrial grade and suitable to operate 24x7, 365 days.
- 1.3 The control system shall have PLC-HMI and intelligent SCADA based architecture. Field sensors and final control elements shall be connected to PLC. Operator shall provide commands via HMI/SCADA for desired operations/sequence; PLC shall execute logic and provide appropriate output to system.
- 1.4 The PLC shall be deployed for safety interlocks, cutoffs, timer based functions, alarms, retaining data/counts & other functions such as intelligent algorithm for better energy conservation for chilled water plant.
- 1.5 Sufficient I/Os, PLC, HMI & SCADA tags, program & storage memory shall be considered for incorporating changes arrived during DAP review and testing feedback.

2 CONTROL PHILOSOPHY:

- 2.1 Each chiller machine shall have its own dedicated control panel, having PLC unit, industrial touch screen human machine interface (HMI) and associated sensors, transducers and final control elements. This panel shall cater all operations of respective chiller.
- 2.2 One PLC shall be provided for monitoring status/parameters and control of chilled water pumps, condenser water pumps, cooling towers and valves.
- 2.3 The PLC mentioned at 2.2. & dedicated control panels of each chiller shall be connected to central SCADA system via industrial standard & proven digital communication for chiller plant remote monitoring, control & operation.
- 2.4 Chilled water plant shall be operated from intelligent SCADA and/or HMI which shall be backed by PLC based cutoffs and interlocks. Valves & Motors shall be operated from SCADA based operator station. The SCADA system shall be capable to change set points for system with logging privileges.
- 2.5 PLC-HMI, SCADA based control system shall provide complete remote monitoring of system to operator by means of status feedback, alarms, data logging with time stamping and report generation along with password protections.
- 2.6 Control system shall be provided in such a way that, it shall be possible to operate individual chiller, pumps, valves, cooling tower fans in case of non-availability of intelligent SCADA and common PLC.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- 2.7 Chiller unit and associated pumps & valves shall be made operable by manual operations under administrative control.
- 2.8 The provision of manual operation under administrative control shall be provided at electrical panels.
- 2.9 System shall be capable to duplicate important parameters of chilled water plant to other SCADA network over Ethernet via fiber optic communication.

3 SCOPE:

- 3.1 Design, detailed engineering, procurement, supply, integration of all Instrumentation & Control items along with accessories, preparation of drawings & documents, PLC, HMI & SCADA programming, testing at VENDOR's/sub VENDOR's works, packing, forwarding, delivery to site, unloading from carriers, storage at site, transportation to the location of installation, fabrication, erection, installation & cabling (signal, control & network), testing, commissioning, carrying out performance/acceptance test at site, preparation of test reports, as-built drawings for Control & Instrumentation system for chilled water plant.
- 3.2 Scope for Instrumentation & Control for chilled water plant includes all field mounted instruments like pressure & temperature gauges/transmitters, flowmeters, ON/OFF & control valves, network switches etc and PLC-HMI & SCADA based control system are minimum required to be supplied by the VENDOR as a package.
- 3.3 One number each, licensed programming software for PLCs, HMI.
- 3.4 Two server cum runtime license with unlimited tags for redundant intelligent SCADA servers shall be provided.
- 3.5 Development license with one of the server cum runtime license mentioned in point 3.4 shall be considered.
- 3.6 Two nos. of industrial PC as a SCADA server cum operator stations.
- 3.7 Development of PLC, HMI and SCADA application program.

4 REQUIREMENTS:

- 4.1 Non-obsolescence:
The PLC CPU and its associated peripherals for the proposed system shall incorporate latest state of art technology, which shall guarantee support for the system up to 10 years from the supply date.
- 4.2 Field Proven Systems:
All hardware, software and firmware supplied with the system shall be field proven prior to placement of order. If desired by purchaser, documentary proof of the same to be submitted.
- 4.3 Small Footprint:
The small footprint of the control system is a must. The small footprint of the components will decrease the number of systems and marshalling cabinets, and the lower number of cabinets can save space as well as cost of investment.
- 4.4 Integrated:

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

It requires capability and features for integrating other control systems of compressed air system, steam generation system etc into one control system for efficient, easy control and monitoring and safety operation of the systems. Control system shall communication/data exchange/interface capability with other systems using industrial standard communication protocols such as Modbus TCP over Ethernet. However development of SCADA only for chilled water plant is in the scope of vendor.

- 4.5 Transparent Data:
Access to data from the field level to the management / enterprise level. With the right access level, the management shall view data directly from the field level.
- 4.6 Application Software Protection:
No software locking mechanisms, which restrict the user for copying the software code, shall be employed. All the application programs shall be editable by the purchaser.
- 4.7 Programming of Software for PLC, HMI & SCADA:
- 4.8 It is within the supplier's scope to perform all the necessary application programming for PLC, HMI & SCADA. Program passwords for all application program, functional blocks to be provided to purchaser for editing program if desired. OEM/Consultant/Integrator shall not retain any password.
- 4.9 Fault Tolerance Requirement:
No single communication or power supply fault should result in the system failure & affect the non-availability of system.
- 4.10 Self-Diagnostics Requirement:
All types of required self-diagnostic features, (that include but not be limited to I/O Diagnostics, CPU Diagnostics, Power supply diagnostics, Communication Diagnostics etc.), to detect faults shall be available in system. Online diagnostics shall be made available in the system.
- 4.11 Maintainability Requirement:
System shall be modular type in design so that identification and replacement of faulty modules will be easy and quick.
- 4.12 The VENDOR shall provide sleek, elegant & sturdy panel. The panel shall be lockable. The panel shall be free standing type. The panel shall house PLC, backplane, power supply modules, communication modules etc.
- 4.13 This panel shall communicate with intelligent SCADA station with Modbus TCP over Ethernet.
- 4.14 The control voltage for I&C system shall be **24V DC**.
- 4.15 SENSORS:
Field sensors for pressure, level, flow, temperature etc for measurement & display shall be rugged, proven and industrial grade. The ranges and sizing of these sensors shall be suitable for design calculations of the chilled water plant.
Thermowell shall be SS 316L and made from bar stock with suitable thread for sensor mounting.
All sensor tapping shall be provided with isolation. Sensors shall be mounted with standard SS compressive fittings.
- 4.16 Alarms:
Individual chiller machine alarms shall be provided on HMI and entire system alarms shall be displayed at intelligent SCADA screen for notification to operator. These

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

alarms shall comprise I&C system alarms, machine parameter alarms, status feedback, Instrument / device failure alarms etc.

4.17 Junction box:

Junction boxes (JB) shall be provided in areas such that field sensors shall be terminated to JB and multi core cable shall run up to PLC panel. Sizing and quantity of JB shall be provided such that optimum number of cable shall be layed from filed to PLC panel.

4.18 Ethernet Network:

The control system architecture shall be based on the open and standard Ethernet technology as its infrastructure backbone communication network by industrial managed switches.

The IO ring network shall be based on Ethernet technology with data 100 Mbps data transmission speed.

4.19 Signal, Control and Communication cables:

Signal and Control cables shall in the scope of the VENDOR . The Signal and Control cables shall be used for connecting field instruments to the panels via junction box along with accessories such as lugs, ferrules, cable glands etc. The communication cables shall be used for establishing communication between as per the architecture. Detailed specification for the cables is provided in subsequent sections.

4.20 Additional instruments required to make the system complete and functional shall be supplied by the VENDOR.

4.21 All the field instruments shall be supplied as specification stated below.

4.22 Erection material for all field instruments shall be as per standard engineering practice.

4.23 Any other item and accessories not mentioned above but required for completeness and functionality of the system.

4.24 Instrumentation & Control Scope of work of Package VENDOR shall include but not limited to this section.

4.25 The control system shall be immune to electrical noise including RFI/EMI encountered in typical industrial plant.

5 GENERAL SPECIFICATIONS FOR MAJOR ITEMS:

Instrumentation and Control items, components, devices, sensors shall be industrial grade with proven technology. VENDOR shall select items, such that at-least for 10 years support from OEM and spares shall be available in open market. Proprietary, Obsolete model/make items/components shall not be selected and considered.

5.1 PROGRAMMABLE LOGIC CONTROLLER:

- a. The PLC shall be of latest technology and work on industrial open architecture. It shall not be proprietary in nature.
- b. It shall be scalable, modular in construction, easily accessible for maintenance and servicing.
- c. The I/O shall be galvanically isolated and protected against short circuits.
- d. Sizing and selection of the PLC shall be as per the detailed design of the system.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- e. The controller shall be hot swappable. The same shall have inbuilt LED indication for status monitoring and fault indications.
- f. The microprocessor of the CPU module shall be multi-function microprocessor architecture and shall be of latest technology. The CPU shall capable to execute logic application program and communication with SCADA, HMI simultaneously.
- g. Memory & Data Storage:
The CPU module shall have integrated flash memory to back up the application, keep the data intact and general context of the controller. The CPU module shall also have the optional Gigabytes card as storage and as a storage backup.
- h. The CPU module shall have Real Time Clock & Time Synchronization facility.
- i. The CPU module shall have LED display for CPU diagnostic and status indicator for the first check of the CPU module. At least the LED indication shall indicate:
Running status / Error status / I/O module status / Backup status to indicate the whether there is an SD card installed or not / The Ethernet traffic status.
- j. CPU diagnostics and alarms shall also be displayed on HMI and SCADA screens.
- k. The controller shall comply with the Five IEC 61131-3 programming languages.
- l. The controller shall communicate via MODBUS TCP protocol over Ethernet with SCADA and HMI. MODBUS TCP memory mapping, I/O address, temporary registers of the controller shall be available to integrate with third party industrial automation system.
- m. The controller shall preferably have a non-volatile memory.
- n. It shall be possible to synchronize the controller with the intelligent SCADA system.
- o. HMI display shall provide the following information to operator. In addition, all the operation data shall be accessible via touch commands.
Discharge temperature / Discharge superheat temperature / Condensing pressure / Condensing temperature / Liquid line refrigerant temperature / Liquid sub-cooling temperature / Condenser approach temperature / Entering condenser water temperature / Leaving condenser water temperature / Condenser water flow rate / Evaporator pressure/Evaporator temperature / Entering chilled water temperature / Leaving chilled water temperature / Evaporator approach temperature / Evaporator water flow rate / Suction temperature / Suction superheat temperature / Oil feed temperature / Oil sump temperature / Oil feed pressure / Oil differential pressure / Motor amps (0 to 5A signal from Purchaser's C.T. This should be connected through interposing CT to protect instrumentation / Motor amps at % of RLA / Total hours of operation / Number of starts / Hours since last start / Time of last start / Time of last stop.
Unit status: Start-up sequence status / Shutdown status / Operational status must be displayed on touch screen.
- p. HMI display shall provide the following information to operator:
Fault history (minimum 8 faults) with time/date must be displayed on touch screen / Critical sensor values at time of faults / High discharge pressure set point / Low evaporator pressure set point / Manual loading must be present / Maximum amp. Load must be displayed on touch screen & setting must be possible / Minimum amp. Load must be displayed on touch screen & setting must be possible / Chilled water set point / High discharge super heat / Low discharge super heat.
- q. The controller shall sense any abnormal condition and take the necessary anticipatory action to either unload or shut down the compressor.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- r. Following minimum safety shall be incorporated in the control system and shall be indicated on the display:
Low discharge Pressure / High discharge Pressure / High discharge Temperature / Condenser pressure low – freeze / Low evaporator pressure - no load / Low evaporator pressure – unload / Low evaporator pressure – SD / Evaporator pressure low – freeze / High suction superheat / Low motor current / High motor current / High motor temperature / Vanes open during start / Low oil differential pressure / Low oil feed temperature / High oil feed temperature / No condenser water flow / No evaporator water flow / High discharge super heat / Low discharge super heat / Starter fault.
- s. Sensor Failures must be displayed for the following:
Liquid line temperature / Discharge temperature / Suction temperature / Entering evaporator water temperature / Entering condenser water temperature / Leaving evaporator water temperature / Leaving condenser water temperature / Evaporator pressure / Condenser pressure / Oil feed temperature / Oil sump temperature / Oil pressure / Breaker failure to trip.
- t. Each fault should be indicated separately for proper diagnosis of cause of failure.
- u. The controller shall possess multilevel password protection capabilities to prevent unauthorized access to set points and to the Service Test mode.

5.2 HMI:

- a. It shall be advanced industrial touch screen display and shall be compatible with above PLC.
- b. Display size : 12 inch.
- c. Display resolution : 1024 x 768 pixels XGA.
- d. Display type : Backlit colour TFT LCD.
- e. Display colour : 65536 colours.
- f. Processor : Advance with atleast 266 MHz frequency.
- 1. Software : Licensed software for development of HMI screens.
- g. Memory : 512 kB (Min) of data with battery backup.
- 1. Communication ports : Programming and communicating with PLC (Ethernet).
- h. Programming port shall be separate and independent.
- i. Supply voltage : 230V AC.
- j. Inrush current : <= 30 A.
- k. Power consumption : Less than 50 W.
- l. Real-time clock : Built-in.
- m. Memory type 1 slot for Compact Flash card supports up to 500 MB.
- n. Mounting : Flush mounting.
- o. Enclosure material Aluminium alloy.
- p. Temperature : Up to 50 °C.
- q. Relative humidity : Up to 90% without condensation.
- r. Degree of protection : IP20 (rear panel) & IP65 (front panel) conforming to IEC 60529.
- s. EMI/EMC : Conforming to IEC 61000.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

5.3 INTELLIGENT SCADA:

- a. An intelligent SCADA software shall be standard, commercially available and industrially proven SCADA software package suitable for process control and data acquisition. SCADA software shall be able to communicate with several PLCs of control system for sending commands and acquiring data via MODBUS TCP over Ethernet.
- b. Hot standby, redundant SCADA system shall be provided.
- c. It shall also capable to transmit data to other SCADA server for monitoring and indication.
- d. System shall be provided with redundancy for power supply, SCADA servers and communication (RING topology).
- e. All full-size dynamics graphics display pages shall include the page name, current time and date together with details of the last 3 alarms that have occurred and the current operator name.
- f. The screens must accurately show all devices and equipment that is part of the control loops. These items must be done in accordance to the configuration standards. The graphics display shall at least shall show the tag name, dynamic process value of important parameter, equipment status and alarm condition.
- g. Every operator activity from login to change the system parameters shall be logged in with time stamp in order to provide the detailed information for further analysis.
- h. The system shall have the capability to provide pop-up windows or faceplate of the device status pages or any other graphical display for more detail information. To minimize operator confusion, pop-up windows shall be capable of being configured so that multiple copies of the same popup cannot be opened on the same workstation at the same time. Faceplates shall be automatically generated by the software to allow for control and monitoring purposes.
- i. The system shall have alarm display. The alarm display shall indicate the time, tag name and description, active / de-active and acknowledge and unacknowledged of the alarm event.
- j. The software shall provide multiple levels of alarm priority or category. The priority of an alarm shall be identifiable by the color and font settings of the alarm message on the screen. The color coding of prioritized alarm messages shall be configurable by engineers
- k. Global acknowledgment of alarms from any station on the network shall be available.
- l. It shall facilitate the operator to monitor and control the chiller plants i.e chillers, pumps, valves, cooling tower fans, flow, temperature, pressure etc based on refrigeration load in the system with the help of controllers & also SCADA system with the provision of Automatic & Manual control from local control room.
- m. Intelligent SCADA software shall be capable to integrate control system for other equipment's/systems like compressed air system and steam generation system in future if desired by purchaser.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- n. Intelligent SCADA system shall display and store all process & electrical parameters of chilled water plant inclusive of process parameters available in controller and electrical parameters from electrical panels. This shall also include directly display TR developed by the chiller and the kW input to chiller.
- o. The SCADA servers for chilled water system shall be a panel mounted industrial grade PC with 23" LED display with suitable licensed OS and Microsoft office software. Licensed copy of all software resident in the PC for operating and engineering shall be provided on CD/ DVD medium.
- p. Operating console shall be capable for doing following functions:
Energy parameters of the machine to be displayed and logged with time stamp.
Machine operating status shall be displayed on graphic user friendly screen.
Machine operating parameters, alarms, trip shall be logged with time stamp.
- q. The system shall perform differential temperature controlled automatic start and stop of the chiller.
- r. The control system shall be secure against unauthorized operation.
- s. The control system shall have auto-restart after power failure which shall be site selectable.
- t. The system shall be capable to crate multi-level user defined logins such as operator, Supervisor, Administrator etc. Different level passwords shall be set for accessing configuration and control settings. The passwords shall be user configurable.
- u. The software shall provide system security features.
- v. The system shall have built in self-diagnosis to facilitate trouble shooting and maintenance.

5.4 PRESSURE TRANSMITTER:

- a. Service fluid : Water/Air.
- b. Type : Piezo-resistive/Capacitance/Strain gage
- c. Transmitter Type : SMART, Pressure Transmitter
- d. Range : Suitable Gauge and/or differential pressure
- e. Wetted parts MOC : SS304L/SS316L
- f. O-rings : Viton
- g. Accuracy : $\pm 0.5\%$ FS, inclusive linearity, hysteresis & repeatability
- h. Long Term Stability : $\pm 0.1\%$ of URL for one year period
- i. Static pressure rating : 1.5 times normal range or more
- j. Over pressure rating : 1.5 times the rated pressure
- k. Output : 4-20 mA DC, 2 wire, HART Protocol
- l. Power Supply : 24V DC
- m. Load Resistance : min 600 ohm at 24 V DC
- n. Protection : Short circuit & reverse polarity protection
- o. Process connection : As required with NPT
- p. Electrical connection : DIN43650 / Hermitically sealed
- q. Operating temperature : Up to 50°C
- r. Temperature error : 0.001% /°C
- s. Relative humidity : Up to 90%

SPEC. NO.:

NRB/128-
CHW/INRP/2020

**NUCLEAR RECYCLE BOARD
BHABHA ATOMIC RESEARCH CENTRE**

**TECHNICAL SPECIFICATIONS FOR CHILLED
WATER PLANT**

PROJECT:

CHILLED WATER
PLANT (UTILITY
BLOCK-2) AT INRP
TARAPUR

5.5 LEVEL SWITCH:

- a. The level switch shall be weatherproof with rugged construction, easy to mount with flange or threaded connection.
- b. It consists of a guide tube, float & housing with electronic circuit
- c. Contacts shall be connected to PLC & MCC system directly
- d. Process Fluid : Water.
- e. Length : As per requirement
- f. Process connection : Threaded NPT / flanged
- g. Process connection MOC : SS304 / SS316
- h. Wetted parts MOC : SS304 / SS316
- i. Float dimensions : As per range
- j. Switching voltage : 24VDC & 230V AC
- k. Process temperature : 50 °C maximum
- l. Process pressure : As desired
- m. Specific gravity : Water and as desired
- n. Enclosure MOC : Die cast aluminium
- o. Enclosure protection : Weatherproof IP66
- p. Cable Glad : NPT

5.6 FLOWMETERS:

- a. The flowmeters selection shall be based on the service fluid.
- b. The sizing shall be done as per pipe size and pressure, type of fluid.
- c. The flow meters shall be capable to transmit continuous flow data by means of 4–20 mA DC output signal. This signal shall be directly hooked to PLC.
- d. The power supply shall be 24 V DC. Preferably loop powered.
- e. Material of construction for wetted parts shall be SS.
- f. Process connection shall be suitable sized SS flanges.
- g. Suitable SS spool shall be provided for all rotameters to be used during Breakdown / maintenance.

5.7 SOLENOID VALVES:

- a. Operating voltage shall be 24V DC.
- b. It shall be NAMUR or manifold mounted.
- c. Coil shall have LED status indication.
- d. Valve body shall be anodized aluminium.
- e. The SV shall have manual over ride provision.

5.8 TEMPERATURE SENSORS:

- a. Type : T type (Copper-Constantan), Mineral Insulated / RTD

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- b. Sheath material : SS 316L
- c. Sheath Length : As per Pipe Mounting and location
- d. Sheath Overall dia : 6 mm OD
- e. Thermowell Material : Same as pipe
- f. Thermowell Type : Drilled Barstock,
- g. Transmitter Mounting : Head mount type of transmitter with accessories
- h. Accuracy : Class 1 (1.1°C or 0.4% of Reading whichever is higher)

5.9 TEMPERATURE TRANSMITTER:

- a. Type : Universal type
- b. Output signal : Two wire 4-20 mA DC,
- c. Smart features : Required with HART Protocol
- d. Accuracy : ± 1°C of Reading
- e. Stability : Better than ± 0.1 % of span for one year period.
- f. Cold Junction Compensation : In- Built for the range the range of 0°C to 55°C
- g. Broken Sensor Protection : Built in and shall be site selectable
- h. Input/Output Isolation : 1500 V AC between Input and Output
- i. Insulation Resistance : >100 MΩ (Between Terminal & Body)
- j. CE marking : Required
- k. Mounting : Thermocouple, RTD head mounted
- l. Power Supply : Loop Powered 24V DC on Two Wire Transmission
- m. Ambient Condition : 20°C to 55°C with up to 95% RH

5.10 PRESSURE GAUGE:

- a. Service : Water
- b. Sensing element : Bourdon type, ANSI 316SS
- c. Accuracy : ± 1.0% of Span
- d. Range : Gauge pressure as desired
- e. Readability : 1% of Span
- f. Angle of the Scale : Approximately 270°
- g. Over Range protection : 50% of total Range
- h. Process Temperature. : Ambient to 60°C
- i. Case : Circular
- j. Dial size : 100 mm
- k. Dial colour : White back ground with black graduations
- l. Case colour : Black, Anticorrosive paint
- m. Bezel Ring : Screwed
- n. Process Connection : ½" NPT(M)
- o. Mounting : Direct mounting
- p. Entry Connection : Bottom
- q. Socket material : ANSI SS 316
- r. Case material : Aluminum with epoxy painted

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- s. Dial Material : Duralumin or other suitable light material
- t. Window Material : Shatter proof glass
- u. Pointer : Micro adjustable, Aluminum finished black

5.11 CABLES:

5.11.1 SIGNAL CABLE:

- a. The cables shall be of copper conductors in multi strands, PVC insulated, PVC inner sheath & FRLS PVC outer sheath and GI wire armoured. Adequate insulation shall be provided for the cable to operate continuously at the specified voltage with a high degree of safety and reliability throughout the life of cable. The insulating and sheathing materials shall be of high quality PVC.
- b. The signal cable shall be manufactured as per IS 1554. The signal cables shall be multi stranded twisted pair with minimum 1100 V grade, 1 mm² copper conductor, PVC insulated, over all screened with aluminium mylar tape. A drain wire shall run continuously along the length of cable and touching with the overall screened. The signal cable shall consist inner sheath and FRLS outer sheath grey in colored.

5.11.2 CONTROL CABLE:

- a. The cable shall be of copper conductor in multi strands, PVS insulated, PVC inner sheath & FRLS PVC outer sheath and GI wire armoured. Adequate insulation shall be provided for the cable to operate continuously at the specified voltage with high degree of safety and reliability throughout the life of cable. The insulating and sheathing materials shall be of high quality PVC.
- b. The control cable shall be manufactured as per IS 1554. The cable shall be multi stranded with minimum 1100 V grade, 1.5 mm² copper conductor, PVC insulated. The control cable shall consist inner sheath and FRLS outer sheath, black colored.

5.12 CONTROL PANELS:

- a. Panels shall be free standing, fully enclosed with double doors on rear/front side.
- b. VENDOR shall generate detailed engineering & manufacturing drawings and sought approval of PURCHASER prior to fabrication.
- c. All instruments, devices and electrical loads shall be possible to isolate individually from loop and power supply.
- d. Industrial managed network switches, cable channels, wires, lugs, terminal blocks, ferrules, supply louvers, exhaust fans and other accessories for realization of functionality of panel are in the scope of supplier.
- e. Control panels shall be fabricated with angular structure, wrapped with CRCA sheets. The thickness of the sheets are mentioned below:
- f. Front plate : not less than 1.5 mm for mounting instruments
- g. Sides and bottom : not less than 1.5 mm
- h. Cable gland plate : not less than 2.0 mm at top/bottom

SPEC. NO.:

NRB/128-
CHW/INRP/2020

**NUCLEAR RECYCLE BOARD
BHABHA ATOMIC RESEARC CENTRE**

**TECHNICAL SPECIFICATIONS FOR CHILLED
WATER PLANT**

PROJECT:

CHILLED WATER
PLANT (UTILITY
BLOCK-2) AT INRP
TARAPUR

- i. Doors : not less than 1.5 mm
- j. Lockable-hinged doors shall be provided at rear side of the panel. The handles for these doors shall be flushed with the panel surface.
- k. Operating Conditions : Temperature up to 50°C, Relative humidity up to 95%.
- l. Shade of the paint shall be pebble gray semi gloss RAL-7032 for external and signal white semi gloss RAL 9003 for internal.
- m. Terminals to be used for signal and power supply connections to the instruments/components shall be screw type, suitable for taking conductor up to 2.5 sq. mm. The terminals carrying voltage of 120 volts and above shall be provided with suitable protective covers
- n. Physical separation shall be provided between DC and AC supply terminals and cables.
- o. For connecting outputs control signal to filed devices, fuse terminal blocks shall be used.
- p. Minimum 20 AWG standard conductors with PTFE (Teflon) / FRLS 500V grade sheath suitable for maximum conductor temperature of 150° C shall be used for internal wiring.
- q. Proper illumination and ventilation inside panel shall be provided.
- r. Panel shall be minimum rated for IP 54.
- s. Separate earth bus bar connection for shield, signal and panel electrical lighting which shall be connected to signal earth and safety earth respectively.

6 POWER SUPPLY FOR INSTRUMENTATION & CONTROL:

- a. Two electrical power levels are proposed for I&C System.
- b. 24 V DC power for control supply, field devices like transmitters, sensors, solenoid valves and panel devices like push buttons, distributors/isolators, alarm trip units, relays, indicating windows etc.
- c. 230 V AC for PLCs, power supply and other panel mounted instruments.

7 TAGGING:

Instrument tag number shall be unique. Same tag number shall be given for instruments which are coming in open or close loop. For example, LT-101, LI –101, LAL-101 can exist together. Loop number for each type shall not be repeated irrespective of system number.

8 DOCUMENTS:

- 8.1 Documents shall be submitted during bidding by participating BIDDERS:
 - a. Compliance for instrumentation and control requirements.
 - b. Proposed system architecture.
- 8.2 Documents to be submitted after award of contract for approval:
 - 1. Design report and detailed system architecture of control system.
 - 2. Detail engineering specification and data sheets
 - 3. Area layouts with respect to I&C
 - 4. General arrangement drawing and Internal GA drawing for Panels
 - 5. Bill of material for Control system

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

6. Interlock, Cutoff & Alarm list
7. Operation sequence and SCADA Screens
8. Instrument installation drawings
9. Network diagram, cable schedule and cable termination schedule
10. Wiring and termination drawing for panels
11. Operating and maintenance manual for control system.
12. Pdf copy of final PLC program.

9 CABLING:

- a. Cable trays shall be used to carry the instrumentation signal and control cables from different areas/field to the control room/JP/Panels/MCC and vice versa.
- b. Cable trays shall be perforated GI sheets (painted) 2 mm thick. Cable trays of suitable size (50/150/300 mm) widths are used for laying cables.
- c. While laying different voltage grade of cable multi tier scheme shall be used. A minimum distance of 300mm is maintained between layers. Higher voltage grade cables are run on upper layers.
- d. Cables shall be neatly tied or saddled inside the trays so as to provide sufficient mechanical support.
- e. Armoured cables shall be used wherever it is laid in open areas.
- f. Cables shall be securely glanded using compression type glands and terminated using proper lugs and sleeves.
- g. All the cables shall be identified by cable numbers and terminations marked with labels.
- h. Cross ferrule marking shall be made on the cable sleeves for identification of incoming and outgoing wires and terminals. Cross ferruling shall be used for Internal panel wires also.

10 TUBING:

- a. Instrumentation impulse and pneumatic supply tubing shall be done using 6mm OD, 1 mm thick seamless tubes of SS 304 L material as per ASTM A 269. 6mm tube provides sufficient flow and also gives optimum response times.
- b. All the associated fittings shall be stainless steel, double ferrule type compression fittings for tube terminations.
- c. Instrument fittings shall be NPT threaded with ferrules wherever required.
- d. Tube fittings shall be of SS304/SS316.

11 GROUNDING:

- a. All the signal cable shields/screens shall be shorted on the control room side and shall be connected to the signal ground.
- b. The grounding conductor (copper) shall offer a resistance of less than 1 ohm. Signal ground has its own earth pit and separated from plant's safety earth.
- c. All instrument chassis and panels' body shall be connected to plant's safety earth having a dedicated earth pit.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
---	--	--

d. This chassis ground also shall have its own dedicated earth pit.

12 ERECTION:

12.1 POWER SUPPLY:

The single point of 230V AC, 50Hz. (UPS) will be provided at one location for instrumentation & control system by the PURCHASER. Further distribution/conversion to other voltage level with all electrical safety switches and miniature breakers shall be in VENDOR's scope.

12.2 AIR SUPPLY:

- a. 6 kg/cm² instrument air tapping point will be provided by PURCHASER.
- b. Subsequent stepping down of air pressure for desired application shall be in VENDOR's scope.
- c. Necessary air headers along with suitable rated PRV shall be provided for air supply to different instruments or final control elements.
- d. Each header shall be proved with local pressure gauge and drain valve, isolation valve etc.
- e. Material of construction shall be SS 304L/316L.

13 INSTALLATION & COMMISSIOING:

- a. At site, Erection, Installation and commissioning activities are in the scope of VENDOR.
- b. The vendor shall submit a detailed plan, Procedures and schedule for erection and commissioning of C & I systems and the same shall be approved by the purchaser. All works shall be carried out as per the plan.
- c. The VENDOR shall depute trained work force comprising I&C engineer, supervisors and technicians.
- d. Delivery, safe storage and handling of delivered martial at installation site shall be carried out by VENDOR.
- e. Arrangement of material handling machines and tools is in the scope of VENDOR.
- f. VENDOR shall have safety norms and guidelines for their personnel during material handling, installation of instruments, cabling and testing of system.
- g. VENDOR shall provide suitable & appropriate safety tools and gadgets during work for their personnel during entire contract execution period.
- h. VENDOR shall also arrange suitable tools and machines for installation of instruments.
- i. For testing at site, VENDOR shall arrange sufficient testing and calibration instruments and tools for successfully carrying out testing and commission activities.
- j. VENDOR shall generate commissioning reports after successfully completion of testing and commissioning.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

14 INSPECTION AND TESTING:

- a. VENDOR shall prepare a Quality Assurance Plant (QAP) and sought approval of PURCHASER.
- b. Testing and inspection shall be done in two stages.
- c. Factory Acceptance Test (FAT):
VENDOR shall offer tests at their works mainly for PLC-HMI & SCADA before dispatch of the material to site. The tests will be witnessed by the PURCHASER. The tests shall include a burn-in-test for 72 hrs.
Calibration and Test reports for all bought-out items shall be provided.
- d. Site Acceptance Test (SAT):
Complete integrated testing of I&C shall be performed to ascertain fulfillment of design intent. VENDOR shall prepare SAT plan and the same shall be approved by the PURCHASER.
Full integrated site acceptance test shall be performed before hand over of total system to the PURCHASER.
The test shall demonstrate all the system functionality. The supplier shall provide all personnel, test facilities, equipment and tools etc. for the same

15 APPLICABLE STANDARDS:

Following Codes/Standards shall be followed for design & detailed engineering of the I&C System.

- a. ISA S 5.1 Instrumentation symbols and identification
- b. ISA S 18.1 Annunciator Sequences and Specifications
- c. ASME PTC 19.2 ASME performance test codes – supplement on Instruments and apparatus, Part –2 pressure measurement
- d. ASME PTC 19.3 ASME performance test codes – supplement on Instruments and apparatus, Part – 3 temperature measurements
- e. IEC 584 Thermocouples
- f. BS 1042 Flow Measurement.
- g. IEEE 336 Installation, inspection and testing requirements for power, instrumentation and control equipments
- h. IS 9000 Environment testing
- i. IS 5 1994 Colors for ready mixed paints and enamels
- j. IS 1554 PVC insulated heavy-duty cables
- k. BS 5308 Pat-II Specification for instrumentation cable
- l. IS 3624 Pressure & Vacuum gauges
- m. IS 2952 Recommendations for methods of measurements of liquidflow by means of orifice plates and nozzles
- n. ISA S 7.3 Quality standard for Instrument Air
- o. IEC 61131 Programmable controllers
 - Part-I General Information,
 - Part II Equipment requirement and tests,
 - Part III Programming languages,
 - Part IV User guidelines.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

- Part V Messaging service specification
- 16 LIST OF DRAWINGS:**
System Architecture for (TYPICAL) : NRB/IP/CW/NA/01

PART-III

ANNEXURE TO FORM OF TENDER

DOCUMENTS

The tenderer is deemed to have fully examined the parts of this tender document listed below and is fully informed as to the nature of work and conditions related to its performance.

- Annexure I : Vender Evaluation Proforma
- Annexure II : Schedule of Deviation
- Annexure III : Schedule of special tools
- Annexure IV : Proof of ability

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE – I

VENDOR EVALUATION PERFORMA

(To Be Submitted Along With The Tender After Duly Filling In And Signing By An Authorized Signatory)

Ref: Tender Enquirer No.

Equipment: Water Chilling Machine

Quotation No.

Date: ___ / ___ / ___

Name: M/S _____

Type of company: State/ Central Undertaking/ Public/Private Ltd./ Partnership / Proprietor

1. Registration details

Authority	Registration with date	Item(s) for which registered
S.S.I.		
Directorate of Industries		
DPS/DAE		
Others		

2. Communication Details

	Office	Works
Address		
Telephone no.		
Telex No.		

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

FAX No.		
E-mail Address		
Contact person(s)		

3. Staff Details

Sl. No.	Designation	Qualification	Nos.
1	CEO		
2	Works Manager		
3	Production Manager		
4	Quality Manager		
5	Design Head		
6	Number of total Staff		
7			
8			

4. Performance of 5 years with profit and loss and as anticipated for the current (Attached balance sheet and profit loss sheet)

Year	Capital (Authorized/Working)	Turnover	Profit/Loss

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

5. Machines installed in India

Capacity	Order details	Major Users	Average age of the machine
Upto 500 TR			
500 TR - 1000 TR			
1000 TR and above			

6. Details of orders of similar nature executed during last three years (Attach separate sheets if required)

Year	Purchaser	P.O. No.	Order value

7. Enclose a list of all inspection and test facilities available to carry out the different tests/ inspection specified in this tender specification.

Signature of Authorized Signatory
Company
(Details of signatory)
Name:
Designation:

Seal of the Bidder

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

ANNEXURE-II –SCHEDULE OF DEVIATIONS

A list of deviation from specifications and contract conditions must be submitted as part of tender and they should confirm or otherwise clause by clause meeting the requirements of the specifications.

All deviations from specification, general conditions etc. shall be listed by the bidder classes by clause giving details in the format as below: -

Section	Clause No.	Deviations

The bidder shall certify at the time of offer that the listed deviations are only deviations. If there are no deviations, the bidder shall certify that there are no deviations from specifications and general conditions. In case no deviations listed are furnished at the time of offer, it will be presumed that there are no deviations from specifications and general conditions.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

**ANNEXURE – III
SCHEDULE OF SPECIAL TOOLS**

The bidder shall give list of all special erection and maintenance tools recommended for all equipment.

Sr. No.	Name of Tool	Qty. recommended

**ANNEXURE –IV
PROOF OF ABILITY**

The bidder shall submit a brief list of work executed by him to the standards and tolerances as specified in tender document for DAE units, public utilities and other reputable firms with complete details of addressees, order values, nature of work and date of execution etc. They will also give details of their management set up, works facilities available and testing facilities and quality control set up & mode and execution of site jobs etc.

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

PART-IV

COST STRUCTURE PERFORMA

The tendered shall quote firm prices on the following basis:

Sr. No	Item Description	Qty	Unit Cost (Rs)	Total Cost (Rs)
1.	Design, detail engineering, Manufacture, testing, Supply, installation, site testing and commissioning of Chiller machine (Capacity-1000TR each) with high voltage compressor motor with HV VFD, unit PLC-HMI based chiller mounted control panel along with all instrumentation and controls inclusive of all valves, sensors, transducers, flow meter, pressure switches etc. as per approved design and tender specification mentioned in Part II with charge of refrigerant and lubricating oil in chiller machines for 5000 TR chilled water plant as per technical specification no.: NRB/128-CHW/INRP/2020 & guidance drawings issued with the tender for INRP – Tarapur Project.	5 Nos.		
2.	Design, detail engineering, Manufacture, shop testing, delivery, installation, site testing and commissioning of Cooling Tower Induced Draft type inclusive automatic chemical dosing system, side filtration etc. inclusive of fan, dosing pumps, electrical motor, VFD, structure and accessories etc. as per approved design and tender technical specifications. No. of cells: Five (5) - (4 Operating x 1 Standby).	1 Lot		
3.	Design, detail engineering, Manufacture, shop testing, delivery, installation, site testing and commissioning of pumps along with motor, piping, valves, control valve, strainers, piping supports, VFD and all other accessories for system installation as per tender technical specification and approved design. (5 nos. – Chilled water pump & 5 nos. condenser water pump).	1 Lot		
4.	Design, detail engineering, Manufacture, shop testing, delivery, installation, site testing and commissioning of electrical system, PLC and intelligent SCADA based system for monitoring and control of entire chiller plant that shall	1 Lot		

SPEC. NO.: NRB/128- CHW/INRP/2020	NUCLEAR RECYCLE BOARD BHABHA ATOMIC RESEARC CENTRE	PROJECT: CHILLED WATER PLANT (UTILITY BLOCK-2) AT INRP TARAPUR
	TECHNICAL SPECIFICATIONS FOR CHILLED WATER PLANT	

	include cooling tower system, chilled water pumps, cables and other accessories etc. required for installation and commissioning of system as per tender technical specification and approved design.			
--	---	--	--	--

Note:

1. The sequence and schedule of items to be supplied shall be as per approval from purchaser at the time of DAP approval.

Signature of Bidder