TAMIL NADU GENERATION AND DISTRIBUTION CORPORATION LTD.

2X660 MW ENNORE STPP

TECHNICAL SPECIFICATION

FOR

AIRCONDITIONING SYSTEM

SPECIFICATION NO.: - PE-TS-412-553-A002 (REV-00)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
POWER PROJECT ENGIEERING INSTITUTE BUILDING
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

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INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design (i.e. preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, maintenance tools & tackles, fill of lubricants, chemicals, reagents and consumables required for pre-commissioning, commissioning , performance testing, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation, storage & preservation at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil and structural work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site, training of customer/client O&M staff, handing over and handover in flawless condition to BHEL's customer of **AIR CONDITIONING SYSTEM with mandatory spares** as per details in different sections / volumes of this specification and various pre award agreements for **2x660MW ENNORE STPP at Kattupalli, Chennai, Tamil Nadu..**

1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning, performance and guarantee/demonstration testing of **AIR CONDITIONING SYSTEM.**

1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to highest standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.

1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

1.5 The general term and conditions, instructions to tenderers and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.

1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure

completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under SEC-II of the specification **within 10 days of receipt of tender documents.** In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser / Customer shall prevail and shall be complied by the bidder without any commercial implication on account of the same. Further in case of any missing information in the specification not brought out by the prospective bidders as part of pre-bid clarification, the same shall be furnished by Purchaser/ Customer as and when brought to their notice either by the bidder or by purchaser/ customer themselves. However, such requirements shall be binding on the successful bidder without any commercial & delivery implication.

1.7 The bidder's offer shall not carry any sections like clarification, interpretations and /or assumptions.

1.8 Deviations, if any, should be very clearly brought out clause by clause along with cost of withdrawal in the enclosed schedule (in Sec – II); otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. If no cost of withdrawal is given against the deviation, it will be presumed that deviation can be withdrawn without any cost to BHEL/its customer.

1.9 In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, Sub-Section - C shall prevail over Sub-section – D, however more stringent requirement as per the interpretation of the owner shall apply.

1.10 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.

1.11 For definition of word like Contractor, bidder, supplier, vendor, Customer/ Purchaser Employer, consultant, please refer relevant clause of NIT.

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

CHAPTER 1

PROJECT SYNOPSIS

1.0 GENERAL BACKGROUND AND SALIENT FEATURES

1.1 Introduction

Tamilnadu Generation and Distribution Corporation owns the proposed green-field 1320 MW (2 units of 660 MW each) Coal Based Thermal Power Station at Katupalli. This is an expansion of North Chennai Thermal Power Station (NCTPS) and located on some portion of the ashdyke of NCTPS.

1.2 Location

The proposed site for main power plant is located near Ennore port (approx 5 kms).

The nearest Railway station is at Athipattu Pudunagar (approx 5 kms)

All weather road from Pattamandri on the Thiruvottiyur-Ponneri district highway is the nearest road access.

The nearest airport is at Chennai at a distance of 60 km.

1.3 Type of Plant

The proposed 2x660 MW Super-Critical Power Project consists of coal fired steam generator connected to a reheat type steam turbine generator along with all the required auxiliaries. Circulating cooling water system is envisaged for condenser cooling.

The description and salient technical data of the Steam Generator, Steam Turbine Generator, Auxiliary systems, Electrical, Control & Instrumentation, Civil etc. are explained elsewhere in the specification:

1.4 PROJECT INFORMATION

Project Title : **2x660 MW ENNORE SEZ Coal Based Supercritical Thermal Power Project at Ash Dyke of NCTPS**

Owner : **TAMIL N ADU GENERATION AND DI STRIBUTION CORPORATION (TANGEDCO)**

LOCATION

The site is located near Vayalur Village, Ennore

Latitude	:	$13^0$17' N to $13^0$18' N
Longitude	:	$80^0$18' E to $80^0$19' E
Distance from Chennai City	:	35 km
Nearest Airport is at Chennai at a Distance of	:	60 km
Nearest Seaport is	:	Ennore
Nearest Railway Station is	:	Athipattu Pudunagar (approx 5 kms)

Meteorological Condition

Climate : Tropical ,very dry and hot summer, dry and cold winter and good rain-fall in monsoon accompanied with strong wind.

Climatological data :

Ambient temp. (^{0}C)

Annual Maximum Mean Temp	41.5(^{0}C)
Annual Minimum Mean Temp	24(^{0}C)
Design Ambient temperature	35(^{0}C)

Relative Humidity

Maximum	100%
Minimum	36%
Design	75%

Annual Rainfall

Maximum	2540 mm
Average	1600 mm
Minimum	1175 mm

Prevailing Wind Direction

Nov to Jan – From NW & NE

Feb to Mar – From East & SE

Apr to May – From South & SE

June – From SW

July to Aug – From NW

Sept to Oct – From SE & SW

Wind Speed 11.8 kmph (avg)

50 kmph (max)

Seismic Zone III as per IS:1893-2002

1.5 Access to Site

Site is well connected to all weather road from Pattamandri on the Thiruvottiyur – Ponneri district highway. Site is located adjacent to the Chennai – Howrah broad gauge line and thus well connected by rail also.

1.6 DESIGN INPUT / CRITERIA

System design criteria
The outside design conditions considered are as follows: -

	Summer	Monsoon	Winter
DBT (°C)	**47**	**28.3**	**18.3**
WBT (°C)	**27.7**	**26.7**	**13.8**

The inside design conditions to be maintained in all Air-conditioned areas are:

22 ± 1°C & RH 50% ± 5%.

2X660 MW ENNORE TPS

SERVICE WATER ANALYSIS

Sr. No	Parameter	Unit	SWRO Permeate (After Passivation)
1.	pH at 25^0C	-	**7.5-8.5**
2.	TDS	ppm	**<600**
3.	Calcium	ppm	>50
4.	Magnesium	ppm	3.3
5.	Sodium	ppm	175
6.	Potassium	ppm	5.9
7.	Stronium	ppm	0.03
8.	Ammonia	ppm	0.07
9.	Barium	ppm	0.003
10.	Alkalinity	ppm	>50
11.	Chlorides	ppm	<300
12.	Sulphate	ppm	9.2
13.	Nitrate	ppm	10.4
14.	Fluoride	ppm	0.05
15.	Boron	ppm	0.06
16.	Silica	ppm as SiO_2	0.001

SECTION: I

SUB SECTION: C
PART-1

TECHNICAL SPECIFICATIONS

1. FUNCTION

The purpose of the system is to provide air-conditioning system for different areas of 2 x 660 MW, Ennore STPP under the scope of BHEL.

2. PROJECT STATUS

Basic engineering of AC system such as Heat load, P&ID and capacities of equipment have already been finalized with customer.

Equipment /Layout drawings for specific makes of respective equipment (as per Table 1) have been finalized and are attached in sub section 7 of this specification. In case bidder finalizes these makes, bidder is not required to submit these drawings/documents afresh. However, bidder shall be required to endorse the documents attached in sub section 7 (Appendix 1) during detail engineering.

Further, it may be noted that bidder has the option to choose different makes (other than those for which drawings/ documents have been attached in the specification) for these items from the list of makes of sub vendor items attached at Sub Section E. In such a scenario, Bidder will have to submit Engineering document for such items in line with details mentioned in respective equipment GA/documents attached at Appendix 1. However, any data which is proprietary in nature or standard for the model offered by OEM or not specifically insisted in this tender specification of the respective equipment may be updated/ modified suitably.

Bidders shall make Site visit in order to familiarize themselves with existing condition of site before submitting the bid in order to make their offer complete. BHEL shall also not entertain any cost implication for any lack of input data with regard to site during detail engineering

TABLE - I

Sl no.	Equipment	Make already approved	Document Number /Remarks
1	Chiller	Kirloskar Chillers Pvt. Ltd	For details Refer Appendix 1 attached at the end of the specification
2	AHU	RCS	
3	Cooling Tower	Flowtech	
4	Water Cooled Package AC	Voltas	
5	DX condensing unit	Voltas	
6	Centrifugal Fan for AHU	Nicotra	
7	Pumps	Flowmore	
8	Heater Humidifier	Dasspass Rapid Cool	
9	Non Chemical Type Scale Preventor	Weldon Engineers (Scale Off)	
10	Fan coil unit	Waves Aircon	
11	Fresh air fan	Nicotra	
12	Insulation	As per approved make list	
13	Fire damper	As per approved make list	
14	Grill/diffuser/Gi sheet /Pipes	System Air	
15	Y strainers	DS Engg.	

16	Filters	As per approved make list	For details Refer Appendix 1 attached at the end of the specification
17	Balancing Valve	Advance Valve	
18	Check Valve / Gate Valve	A.V. Valves	
19	Ball Valve	A.V. Valves	
20	Y & Pot Strainer	DS Engineering	
21	Butterfly valve (Motorised)	Siemens	
22	3 way / 2 way mixing valve	Rapid Control	
23	Float Valve	Leader Valves	
24	Balancing Valve	Advance Valves	
25	Electric Hoist	Reva	
26	Chain Pulley	Tractel	
27	Expansion / Make Up Water Tanks	FRP Tanks, as per approved make list	

List of items for which drawings have not been approved and fresh submission of documents is to made by successful bidder during detail engineering is given under **Appendix-I** enclosed at the end of the specification.

ELECTRICAL FEEDER LIST

Approved Electrical Feeder List of various items is also attached under **Appendix-I**. Disregard of the final make of the equipment selected by the bidder, **electrical feeder list has to be complied by the bidder in toto.**

CIVIL INPUTS

Irrespective of the final make of the equipment selected, bidder must comply with civil aspects of AC System indicated in Layout Drawings as the construction of equipment foundation is at different stages at site.

Any modification in the civil foundation due to change in the make shall be done by the vendor subject to acceptance by BHEL.

3. SCOPE OF SUPPLY

Scope of supply by bidder shall comprise of but not necessarily limited to the following. Major equipment details for each AC System are added below. For comprehensive BOQ, please refer the Suggestive Price Format.

Area	Machine Capacity & Configuration	Equipment Location
AC Plant 1 Main Power House	Chiller - 300 TR Actual Capacity, (1W+1S) Cond. Water Pump –307 CMH (1W+1S) Chilled Water Pump –215 CMH (1W+1S)	AC Plant Room at 0.0 M, between E - G Bay Power House Building.
	AHU for CCR Area – 4 Nos. (2W+2S), 54200 CFM, 120MMWC & 111 TR each	AHU Room at 24.0M, B-C Bay Col.13-16
	AHU for UPS Area – 2 Nos. (1W+1S), 31700 CFM, 120MMWC & 60 TR each	AHU Room at 8.5 M, C-D Bay Col.12-13
	Cooling Tower – 337 CMH (1W+1S) Make Up Water Tank – 2 Nos. 8 CMH Expansion Tank – 1 no. 1 CMH	EL. 33.0M, D-G Bay, Col. 14-15

AC Plant 2 & 3 ESP Control Bldg. – Unit 1 & Unit 2	Water Cooled Condensing Unit - 30TR Actual Capacity, (1W+1S) Cond. Water Pump – 30 CMH (1W+1S)	EL. 4.0M Grid B-A, Col. 7-8
	AHU Room – 10000 CFM, 30.0 TR (1W+1S)	EL. 4.0M Grid B-A, Col. 7-8
	Cooling Tower – 35 CMH (1W+1S) Make Up Water Tank – 2 Nos. 2.0 CMH	EL. 9.5M Grid B-A, Col. 6-8
AC Plant 4 Service Building	Water Cooled Package AC – 20 TR (2W+2S)	EL.0.0M PAC Room, Grid AC-1-2
	Water Cooled Package AC – 15 TR (2W+2S)	EL.0.0M PAC Room, Grid AC-8-9
	Water Cooled Package AC – 15 TR (2W+2S)	EL.4.25M PAC Room, Grid AC-1-2
	Water Cooled Package AC – 15 TR (2W+2S)	EL.4.25M PAC Room, Grid AC-8-9
	Water Cooled Package AC – 15 TR (2W+2S)	EL.8.5M PAC Room, Grid AC-1-2
	Water Cooled Package AC – 20 TR (2W+2S)	EL.8.5M PAC Room, Grid AC-8-9
	Water Cooled Package AC – 15 TR (2W+2S)	EL.12.75 M PAC Room, Grid AC-1-2
	Water Cooled Package AC – 20TR (2W+2S)	EL.12.75M PAC Room, Grid AC-8-9
	Water Cooled Package AC – 20 TR (2W+2S)	EL.17.0M PAC Room, Grid AC-1-2
	Water Cooled Package AC – 20 TR (2W+2S)	EL.17.0M PAC Room, Grid AC-8-9
	Cond. Water Pump –350 CMH (1W+1S) Cooling Tower – 385 CMH (1W+1S) Make Up Water Tank – 2 Nos. 8 CMH	EL. 22.50M. Service Building Roof, Grid B-F-6-8
AC System for Auxiliary Control Rooms	Split type air conditioners (air cooled) / Ductable Split AC / Cassette AC Capacity & Quantity as per Document. PE-V0-412-553-A052, Split Ac Schedule along with Heat Load Calculation for Auxiliary Building enclosed under Appendix-I Each Split / Cassette AC / Ductable Split Unit MCB shall be provided with suitable rating voltage stabiliser & MCB for isolation.	

4. SCOPE OF SERVICES

Scope of services by bidder will include but not necessarily limited to the following:

a) Unloading, Storage, handling and transportation at site.

b) Erection & Commissioning of AC System

c) Minor civil work like chipping of foundation, grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself including special type of grouting like GPX2 etc, making opening to suit / finishing of opening after completion of AC Equipment erection, sealing of duct / pipe opening.

d) Making Good / Repairing / replacement of and damaged done by bidder to adjacent structure, pipes etc. while erecting equipment's related to AC System.

e) Pre-Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation like refrigerant, grease, lubricants, anemometer, tachometer, ammeter, voltmeter etc. for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.

f) Inspection & testing, Performance Requirements and Performance Guarantees.

g) Painting of equipment's, valves, pipes and other accessories within scope of supply.

h) Electrical scope as per enclosure elsewhere in the specification.

i) Training of plant Owner's personnel (Min 2 days), O&M operators' personnel on plant operation and maintenance.

j) Relevant requirements as per GTR, GCC & SCC.

k) Any other service required for making the installation complete in all respect within battery limits and for satisfactory erection & commissioning of the system as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of services.

5. EXCLUSIONS

Items of works listed below are excluded from scope of the air-conditioning plant supplier.

a) Construction of AC plant room, air handling unit room, foundations for AC equipment's i.e. Chillers, Package AC, AHU, Pumps, roof/wall openings for ducts, dampers/louvres.

b) False ceiling, drop ceiling.

c) Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers.

d) Various cable & pipe trenches, pipe pedestals, drains, sumps, insert plates for pedestals for pipe supports.

e) DCS Control panel for Operation and control of AC System. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.

6. SERVICES TO BE PROVIDED BY THE CUSTOMER

Relevant services as per GCC & SCC.

7. TERMINAL POINT

Make Up Water	Refer Make Up Water Scheme, Under Appendix-I

Change in location of terminal points by up to 5 meters in plan view and 10 m in elevation view shall have no price implication. Isolation valves at the terminal points shall be in the scope of the bidder.

8. PERFORMACE GURANTEE REQUIREMENTS

Refer Demonstration / PG Test document enclosed under **Appendix-I** for details.

9. PAINTING / CORROSION PROTECTION REQUIREMENT

This will be as per customer specification, C-2A enclosed.

10. CONTROL PHILOSOPHY

Control of both AC & ventilation system shall be done from DCS based control panel located in the AC PLANT-1 Room.

Bidder to refer Control Philosophy for Air Conditioning System for details kept at **Appendix-I**

11. QUALITY ASSURANCE, QUALITY PLANS, INSPECTION & TESTING PROCEDURE:

a) The Quality plans / checklist for the equipment's / instruments are attached under **Annexure-I.** Bidder to follow the same for supplying material.

12. SUB-VENDOR ITEMS

Sub-Vendor for AC System is enclosed under Annexure-VI, Sub- Section – C6

13. DOCUMENTS TO BE SUBMITTED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly as per list given under **SECTION-III**. Any documents other than those indicated in the list will not be reviewed and will not form part of contract.

14. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawing / document along with their status is attached in **Appendix - I**

SECTION: I

SUB-SECTION: C 2
PART-A

CUSTOMER SPECIFICATION
TECHNICAL REQUIREMENT

CHAPTER 19

19.0 AIR CONDITIONING AND VENTILATION SYSTEM

19.1 General

The air conditioning and ventilation system shall be provided so as to achieve inside design conditions for proper performance of equipment and personnel.

The extent of supply under this contract includes all items required to complete the intent of the contract not withstanding the fact that such items may have been omitted from the specification or drawings.

The air conditioning and ventilation system shall also meet the requirements specified elsewhere in the specification.

19.2 Codes and Standards

Relevant Indian/International standards, such as ASHRAE, ISHRAE, AMCA and IS etc. as applicable to AC & ventilation system and latest issues of these applicable codes and standards shall be adopted.

19.3 Design Criteria for Air conditioning system

19.3.1 Dry bulb temperature 47^{o} C.

For other details of ambient conditions, refer published documents for meteorological data for Plant site.

19.3.2 Inside design conditions to be maintained in all air-conditioned areas.

Dry bulb temperature : 22 ± 1.0^{o}C

Relative humidity : $50 \pm 5\%$

19.3.3 A minimum design margin of 10 % shall be considered while sizing AC Plant and related equipment like chillers, chilled water pumps and AHUs for each area. Solar load, all internal loads due to equipment, lighting, fresh air, occupants etc shall be considered while calculating the heat load.

19.3.4 Margins for calculating heat load:

i. 12.5%, 10% & 10% margins on sensible heat, latent heat & overall heat respectively is to be considered while calculating heat load.

ii. For winter load calculations, 50% of the equipment load as available in the room is to be considered.

19.3.5 All windows in the air conditioned area shall be provided with light coloured venetian blinds.

19.3.6 Fresh air quantity of 1.5 air change/hour or $35m^3$/hr per person or suitable to maintain over pressure of 2 MMWC whichever is higher shall be considered.

19.3.7 False-ceiling shall be provided in all air conditioning areas.

19.3.8 For chemical lab, the airconditioning system shall be designed for 100% outdoor air (the room air is exhausted and not recirculated through the A/C unit). 2 x 100 % Split units are acceptable for chemical lab.

19.3.9 To reduce the air-conditioning load the exposed roof slabs (Including beams and column etc.) of air-conditioning areas , air handling units room and Packaged Air conditioners (PAC) rooms shall be insulated with 50 mm thickness fibre glass insulation of density 48 kg/m^3 finished with 26 swg aluminum cladding.

19.3.10 AHU room's walls ,Packaged Air Conditioners room's walls and first 6 meters of supply air duct from AHU/PAC air outlet shall be acoustically insulated with 25 mm thick fiberglass crown 150 of density 48 kg/m^3 and shall be covered with 26G aluminum perforated sheet. Perforation area shall be 30% of free area.

19.3.11 Lighting load of 2 Watts per Ft² or actual which ever is higher shall be considered for heat load calculations.

19.3.12 The occupancy for general/ office area shall be minimum one person per 3 Sq.M and for conference room the same shall be one per 1.5 Sq.M. In the control rooms, control equipment rooms etc, the occupancy may be one person per 20 Sq.M (Minimum).

19.3.13 The Air-conditioning spaces shall be maintained at positive pressure of 2 mmwc to avoid any infiltration of dust.

19.3.14 Plant for all air-conditioned areas shall operate continuous (24 hours a day, 7 days a week except during loss of normal power failure).

19.3.15 Motor operated valves shall be provided as per system requirement for chilling machines, pumps, cooling towers in order to facilitate remote operation of entire air-conditioning plant and to select standby unit.

19.3.16 Noise Criteria – Design noise level shall be of NC 35-45 within Control room, Control equipment room, Instruments and Electronic room and offices.

19.3.17 Design Criteria for Air Inlet Louver – Face velocity of the louver shall be 2.5 m/s (max.).

19.3.18 Design Criteria for Volume Control Damper – Velocity across the Damper shall not exceed 10 m/s.

19.3.19 Duct Design Criteria – Velocity shall be 7.5 m/s.(max.) for main duct, 6.0 M/s. (max.) for branch duct and 2.0 m/s. for the diffusers/grills.

19.3.20 Coil face area of Air handling Units shall be designed considering a face velocity of not more than 2.5 M/ Sec.

19.3.21 Water piping shall be sized for a maximum velocity of 2.5m/sec. However gravity flow/pump suction line shall be sized for a maximum water velocity of 1.5 m/sec.

19.3.22 Refrigerant suction, discharge/hot gas lines & liquid lines shall be sized such that the total pressure drop is equivalent to not more than 1.1 deg C in saturation temperature of refrigerants. However, refrigerant velocity shall not be greater than 0.5 m/sec in liquid line.

19.3.23 All Carbon steel sheets under air conditioning system shall be hot dip galvanized or spray galvanized unless otherwise specified and minimum zinc deposition shall

conform to Class 275 of IS: 277.The air distribution system shall be sized to have a constant frictional drop.

19.3.24 For calculating friction loss in piping system: WILLIAM & HAZEN formula shall be used with C value as 100.

19.3.25 Thermal Insulation Design Criteria –

EQUIPMENT/MATERIAL	THERMAL INSULATION
Ducting	50 mm thick fibre glass of density 48 kg/cum and TF quality finished with 26 swg aluminium cladding. For Exposed ducting, 50 mm thick fibre glass rigid board (density 48 kg/cum and TF quality) finished with 26 swg aluminium cladding.
Refrigerant Piping for Split Air Conditioners and Packaged air conditioners	13 mm thick Nitrile foam.
Refrigerant Piping of Water Chilling Unit	75 mm thick expanded polystyrene (TF Quality) of density 32 kg/cum finished with chicken wire mesh, 12.5 mm thick sand cement plaster.
Chilled Water Piping and associated valves.	Chilled water piping shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum covered with 12.5 mm thick Sand Cement Plaster. The portion of CHW pipe exposed to atmosphere shall be insulated with 50 mm thick (TF quality) expanded polystyrene of density 32 kg/cum and finished with 26 swg aluminium cladding.
Drain Piping from AHU and Chiller	Drain Piping shall be insulated with 25 mm thick EPS (TF quality) of density 16 kg/cum covered with 26 swg aluminium cladding.
Chiller	As per manufacturer standard.
Chilled Water Pump	50 mm thick thermal insulation of EPS (TF quality) of density 32 kg/cum covered with 26 swg aluminium cladding.
Expansion Tank	50mm thick thermal insulation of EPS (TF quality) of density 16 kg/cum covered with Sand Cement Plaster.
Air Handling Unit	Double skin type with PUF insulation
Indoor Unit of split AC	As per Manufacture's Standard
Package A.C	As per manufacturer's standard

19.3.26 Design Chilled water flow shall not be less than 0.7 Cu.M/hr per TR air-conditioning load and design Condenser cooling water flow shall not be less than 1.0 Cu.M/hr per TR air-conditioning load.

19.3.27 For maintenance of compressors/chilling units, pumps, AHUs (air handling units) etc. chain pulley block of suitable capacity and/or suitable structure shall be provided in the AC plant rooms and AHU rooms.

19.3.28 Redundancy of Equipments

The number of chilled water pumps, condenser water pumps and cooling towers shall be equal to the number of chilling units and condensing units.

▪ Chilling Units	-	2 x 100%
▪ Condensing Unit	-	2 x 100%
▪ Condenser water pumps	-	2 x 100%
▪ Chilled water pumps	-	2 x 100%
▪ Package air conditioners	-	2 x 100%
▪ Window/Split air conditioners	-	2 x 100%
▪ FRP cooling towers	-	2 x 100%
▪ Air handling units (DX type)	-	2 x 100% (Per AHU room)
▪ Air handling units water type)	-	Multiple AHUs of similar (Chilled capacities per AHU room
▪ Fresh air fan unit	-	2 x 50% per AHU room

19.3.29 All the pumps shall have 10% margin on capacity and head over the actual requirement.

19.8 Equipment Description

19.8.1 Chilling Unit/Condensing Unit

Type		Water cooled type.
Vibration isolators	:	Steel spring/ Neoprene rubber cushy foot/ neoprene serrated rubber pad type with isolation efficiency not less than 85%.
Compressor Type	:	a) For the Chilling units of T G building control room areas, the compressor shall be Hermetically sealed Screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities b) For condensing units of ESP/VFD control rooms shall be Hermetically sealed screw type operating on R134a/R407C refrigerant complete with accessories and automatic control facilities
Type of drive	:	Motor driven, through direct
Accessories	:	High / Low pressure cutouts, Oil pressure switches, relief valves, Pressure gauges at each stage, lube oil/Control oil pressure gauges, Suction and discharge stop valves, Muffler, Crank Case heaters, Oil filters, Magnetic oil Separators, Temperature indicators for Lube oil/ Heaters, Oil level indicators, Safety thermostat for crank case heater, Vibration Isolators etc.
Condenser		
Type	:	Water cooled, shell and tube type.
Fluid		
	:	Shell side – Refrigerant
	:	Tube side - Water
Capacity	:	To match with respective compressor and to provide atleast 2 deg.C sub-cooling. To store full charge of refrigerant.
Design fouling Factor	:	Not less than 0.0002 (in MKS units)
Shell material	:	Mild steel (IS:2062)
Tube material	:	Replaceable seamless copper (ASME B-111)
Fin material		Copper
Accessories	:	Purge and drain connections, relief valves, liquid line shut-off valves, refrigerant filling charging, flow switches, Isolating valves, Pressure & temperature indicators at inlet and outlet etc.
Refrigerant	:	For chilling Unit- R 134a For Condensing Unit - R-22
Steel structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators
Chiller		
Type	:	DX type and Shell and tube type
Superheating of	:	At least 2 deg.C
Design Fouling Factor	:	Minimum 0.0001 (MKS units)
Fluid	:	Shell side - Water
		Tube side - Refrigerant
Capacity	:	To match with respective plant capacity.

Shell material	:	Mild steel (IS : 2062)
Tube material		Replaceable seamless finned copper
Fin material	:	Aluminium
Accessories	:	Purge and drain connections, Isolating valves, flow switches, Pressure & temperature indicators at inlet and outlet, Anti-freeze thermostats, thermostatic expansion valve or float assembly as applicable, pilot solenoid valve, Relief valves, Operating thermostats for capacity control, supporting frame etc.
Steel Structure	:	The complete condensing/ chilling unit shall be mounted on steel structure and shall be provided with necessary vibration isolators.

19.8.2 **Air Handling Unit (AHU)**

a) Each AHU shall consist of Casing, Fan impeller section, Cooling coil section, damper section, Steel frame with vibration isolators (minimum efficiency of 85%) for the complete AHU, Isolation dampers at the Suction and discharge of each AHU, Pre-filter at the suction and Fine filters (micro-vee type) in the discharge of each individual AHU/common plenum, Absolute (HEPA type) filters in individual discharge of all AHU's/common plenum of Control room, control equipment room, computer, programmer rooms etc and Heater section in the common discharge of AHUs.

b) The casing of AHUs shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 22 swg (0.8 mm) galvanized steel, with 25mm thick polyurethane (PUF) insulation of minimum 40Kg./ Cum density in between. 16 gauge galvanized steel hat-channel shall be used as reinforcing to give structural strength.

c) Face and bypass dampers (motor operated for DX type plant) of opposed blade type shall be provided. Dampers shall be made of 16 gauge G.S sheet metal (class 275 of IS: 277). The area of the bypass section shall be minimum 30% of the coil face area. Damper operating linkage and the operating motor shall be located outside the casing. Each AHU shall be provided with motorized volume control damper at air discharge.

d) Cooling coil shall be of seamless copper tubes with Aluminium fins and shall be provided with suitable drains and vents connections.

e) All filter plenum shall be provided with a walking platform inside the plenum chamber for filter cleaning purpose. Inspection door shall be provided at the plenum chamber and a removable type ladder shall be attached to plenum.

f) Air handling units/centrifugal fans shall be provided with Variable frequency drive (VFD) and velocity sensor/static pressure sensor in supply air path to adjust air flow automatically. The minimum efficiency of VFD at full load shall not be less than 96%.

g) Centrifugal Fan

a)	Fan impeller	:	Forward/ backward curved blade & centrifugal type.
b)	Impeller material	:	Mild steel spray galvanised with minimum zinc deposition conforming to Class 275 of IS:277.

c)	Fan bearings	:	Self aligning type, permanently lubricated, heavy duty with a design life of 10,000 operating hours.
d)	Critical speed	:	First critical speed of rotating assembly shall be at least 25% above the operating speed.
e)	Drive	:	Motor driven. With removable belt guard.
f)	Static pressure (minimum)	:	120 mm wc

19.8.3 **Precision Type Packaged Air Conditioners**

Packaged air conditioners shall be of precision control type complete with hermetic type Scroll compressor ,shell and tube type water cooled condenser, air handling fan, D-X cooling coil, Microvee filters,In-built dehumidification cycle thru solenoid valve for reading ADP, humidifier package with humidistat and other accessories and controls, electrical strip heaters with suitable thermostat, first charge of refrigerant and oil, controls and all necessary instruments and accessories, all housed in a cabinet made of heavy gauge sheet steel finished in epoxy paint of approved colour and suitable for floor mounting. Suitable drain connection shall be provided for removal of condensable collected inside a tray under cooling coil.

i. Compressor shall be hermetically sealed Scroll type with drive motor. It shall be suitable for R22/R407c refrigerant. The compressor shall be mounted on springs at the lower most section of packaged unit such that the same is easily accessible for servicing.

ii. The condenser shall be water cooled shell and tube type having replaceable seamless copper tubes with integral fins and removable head. The condenser shall be provided with fusible relief plug and all other accessories as required.

iii. The air handling fan shall be centrifugal type with forward curved blades and complete with belt drive and electric motor. Each PAC shall be provided with motorized volume control damper at air discharge.

iv. Cooling coils shall be of direct expansion type and made of heavy gauge copper with hydraulically bonded aluminium fins. Rows shall be staggered in the direction of air flow.

v. Filters shall be non-rusting corrugated metallic wire mesh cleanable type and of adequate area so that the air velocity across the filters shall not exceed 2.5 m/sec. Filter shall be in-built with unit heaving efficiency 95% down to 5 microns.

vi. Refrigerant piping shall be heavy gauge copper or IS:1239 heavy class seamless MS pipe complete with thermostatic expansion valve, liquid line shut-off valve, high and low pressure gauges.

vii. Cabinet Construction:

The frame & panel shall be constructed of Cold rolled cold annealed sheet steel duly powder coated and shall be assembled with pop rivets. The side panels of unit shall be double skinned for increase life span and reduction of noise & vibration. Front panel shall be removable hinge for easy service.

viii. De-Humidification

Specific de-humidification cycle (Split Liquid / Split Suction) shall operate by reducing the operating surface temperature in a section of one of the Refrigeration coil by means of a solenoid valve in the Liquid line / Suction line. Full air flow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

ix. All necessary operating and safety controls shall be provided including the following:

Controls:

The controls shall be of microprocessor based programmable PID (Proportional, integral and derivative control logic) controller. The controller shall have a LCD display screen, which shall be visible from the front of the unit without removing any covers/external panels. This LCD display screen should show the following information / data:

a) Modes of operation (cooling, heating, humidification, de-humidification).

b) Simultaneous displays of set temperature and actual temperature and set Relative Humidity and actual Relative Humidity.

c) Date, time and unit identification display.

d) System component Auto / Manual status display on the controller screen.

e) Backup battery charge status display on the controller screen.

f) Visual system alarm indication (along with mutable audio alarm as well).

g) Alarm display menu (incorporating various system alarms like temperature high / low, humidity high / low, Compressor HP/LP, Wet floor and loss of air flow conditions).

h) 24 Hours temperature and relative humidity graph display menu.

i) Programmable services interval indication display / alarm.

There should be a feature to enable operator to program the start-up and shut off of the system components (blower fan start / stop delay, first compressor start / stop delay, second compressor start / stop delay, etc.). Access to the controller settings shall be protected with passwords to prevent against unauthorized access.

Safety Protections:

The unit shall also incorporate the following protections:

a) High pressure trip- Manual reset for each compressor
b) Low pressure trip- Manual reset for each compressor.
c) Single phasing preventers.
d) Reverse phasing
e) Phase imbalancing
f) Phase failure

g) Overload tripping (MPCB) of all components

Safety Interlocks:

Operation of heaters & humidifiers shall be possible only when blower fan is in operation.

Fire detection signal from fire detector system shall be able to switch off the package unit operation in event of fire in conditioned space.

x. A suitable number of vibration isolation pads shall be provided for the packaged units.

19.8.4 **Centrifugal Pumps**

a)	Type	:	Horizontal Centrifugal, Axially split type casing pump
b)	Impeller	:	Closed type
c)	**Material of Construction**	:	
	i) Casing	:	2% Ni Cast Iron : IS:210 Gr. FG-260
	ii) Impeller	:	Bronze IS:318 Gr-2
	iii) Wearing rings	:	Bronze
	iv) Shaft	:	SS 410
	v) Shaft sleeve	:	SS 316
	vi) Lantern ring	:	Brass / Bronze
	vii) Packing	:	As per manufacturer's standard.
	viii) Base Plate	:	Carbon steel as per IS:2062
	ix) Speed	:	Maximum 1500 rpm

19.8.5 **Air Filters**

a) Pre Filter

1)	**Filter medium :**			
	i)	Fibrous material (extruded polyethylene) or felt filter fabric; Dry type with element of 5 ply construction for Fabric type.		
	ii)	V-fold galvanized wire mesh inter spaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.		
2)	**Frame**			
		GI sheet (minimum 18 gauge thick) or Aluminium alloy of (minimum 16 gauge) supported by galvanised steel wire mesh of 10 mm Square with handles.		
3)	**Other requirements :**			
	a)	Suitable aluminium spacers be provided for uniform air flow;		
	b)	Casing shall be provided with neoprene sponge rubber sealing.		
	c)	Capable of being cleaned by water flushing.		
	d)	Density of filter medium shall increase in the direction of air flow in case of metallic filter.		
4)	**Efficiency :**			
		Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 - 76.		
5)	Minimum thickness		:	50 mm for Fabric type.
6)	Face Velocity		:	Not more than 2.5 m/sec.

7)	Pressure drop	:	Initial pressure drop - Not to exceed 5.0 mm WC at rated flow. Final pressure drop - Upto 7.5 mm WC.
8)	Location		
	a) Fabric type	:	1) At the suction of each AHUs (AC system)
		:	2) At the suction of each Fresh air fan (AC)
		:	3) At suction of each PAC unit

b) Fine Filters (Microvee type)

1)	Construction	:	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminium spacers.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS:737)
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame. Capable of being cleaned by air or water flushing.
4)	Efficiency	:	Average arrestance of 80-90% when tested in accordance with BS:6540/ASHRAE–52-76.
5)	Minimum thickness	:	150 mm or 300 mm.
6)	Face Velocity	:	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 18 mm WC.
8)	Location	:	i) At the discharge of each individual AHU (AC system). ii) At the discharge of each Fresh air fan (AC system)

c) Absolute Filter / Hepa Filter

1)	Media	:	100% sub-microscopic glass fibres.
2)	Frame	:	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles.
3)	Other requirements	:	A neoprene sponge rubber sealing shall be provided on either face of the filter frame.
4)	Efficiency	:	99.97 % down to 0.3 micron when tested in accordance with BS: 3928 (Sodium flame test)/FED–209B.
5)	Minimum thickness	:	300 mm
6)	Face Velocity	:	Not more than 1.2 m/sec.
7)	Pressure drop	:	Initial pressure drop - Not to exceed 20 mm WC at rated flow; Final pressure drop - Up to 60 mm WC.
8)	Location	:	At the discharge of each individual AHU feeding to computer rooms, programmer rooms, control room and control equipment room in central control building.

19.8.6 Cooling Tower: It shall be selected for WBT: 28 Deg. C, Approach. 4 Deg. C & Range - Min. 4 Deg. C

Type		Induced draft, cross or counter flow.
Capacity		110% of rated capacity of each cooling water

		pump.
Material of construction of Casing & Sump tank		F.R.P
Fan		Cast Aluminium / FRP Propeller type and multi-blade aerofoil construction with adjustable pitch.
Fill		Non combustible PVC or Equivalent of light grey, cream or white colour.
Louvers		F.R.P / PVC / Aluminium.
Nozzles		Brass with chrome plating/Polypropylene.
Eliminators		In removable sections to reduce the drift loss to 0.2% of water flow.
Supporting structure		Mild steel with spray galvanisation or epoxy painting.
Strainer at water outlet		Plate strainer made of GI /SS wire mesh of 16 gauge.
Bird screen		25 mm square made of GI/SS wire mesh of 16 gauge.
Ladder		Hot dip galvanised steel ladder for each tower.
Distribution Pipe		Galvanised MS pipe.
Accessories		Drain connection with isolation valve Make up connection with ball - float valve, back up gate valve and a bypass with a gate valve for manual operation. Overflow connection Equalizing connection to connect sump of all the towers wherever applicable. Access door in louvers / fan deck.

RCC foundation for cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by AC supplier.

Individual sets of cooling towers shall be provided for Central chilling plant in T G building areas, DX type air conditioning system for ESP/VFD control room and Packaged type air conditioning systems for Administrative building, Switchyard control room, AHP control room and other areas/control rooms.

Non- Chemical Type Scale Preventor

The unit should be a non-chemical on-line type scale preventor not requiring any chemicals. Non-chemical water treatment system should prevent the formation of hard scale in cooling circuits of air conditioning equipment.It should work with a combination of Adsorption, and Turbulence. The inner core should be able to convert the hardness salts into colloidal particles.The unit should not require any electricity or any other source of energy.The unit should not have any recurring, operating and maintenance cost.The size of the unit shall be determined based on the water quality and water flow rate.The unit shall be installed in the condenser water circuit.The outer casing should be of stainless steel.The method of checking the performance of system through computer simulation shall be provided

19.8.7 **Air Distribution System**

I) Galvanized sheet steel fabricated rectangular ducting shall be provided for the low pressure air distribution system. The thickness of sheets type of bracings and other fabrication details shall be as specified below: -

	Larger dimensions of Duct	Thickness of GS sheet (mm)	Type of Transverse Joint Connection	Bracing
a.	Upto 600	0.63 (24 g)	S-drive, 25 mm pocket or bar slips on 2.5 m centers	25 x 25 x3 angles 1.2 m from joint
b.	601 thru 750	0.63 (24 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x 3 angles braced at 1.2 m from joints.
c.	751 thru 1000	0.80 (22 g)	S-drive, 25 mm pocket or 25 mm bar slips on 2.5 m centers	25 x 25 x3 angles braced at 1.2 m from joints.
d.	1001 thru 1500	0.80 (22 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers	40 x 40 x 4 angle braced at 1.2 m from joints.
e.	1501 thru 2250	1.00 (20 g)	40 x 40 angle connections or 40 mm pocket or 40 mm bar slips with 35 x 3 bar reinforcing on 2.5 m centers.	40 x 40x 4 angle braced at 600 mm from joints.
f.	2251 and larger	1.25 (18 g)	50 x 50 angle connections or 40 mm pocket or 40 mm bar slips 1 m centers with 35 x 3 bar reinforcing	50 x 50 x 5 angle braced at 600 mm from joints.

II) The longitudinal seams and transverse joints shall be flat and smooth inside the duct. All rectangular ducts shall be flat on face and pittsburgh on corner of duct. Duct pieces shall be joined together by 'S' and drive slip joints or by angle iron flanges. The size of connecting flanges shall be same as that of the bracing angle. The interconnecting flanges shall be connected with 10 mm galvanised bolts and nuts at about 125 mm centres. All flanges shall be connected to the ducts by rivets at about 125 mm centres. The ducts shall be tapped 6 mm across the flanges. All flanged joints shall have 6 mm thick felt packing stuck to the flanges with shellace varnish or approved equal adhesive. The holes in the felt packing shall be burnt through.

III) Ducts 2250 mm and larger require special field study for supporting. Unless otherwise specified, the ducts with larger side greater than 2250 mm shall be supported by 15mm MS rods and 65x65x5 mm MS angles while those below 2250 mm shall be supported by 10 mm MS rods and 50x50x4 mm MS angles. The MS rods and angles shall be given two coats of redoxide primer paint and final coat of silver colour. The duct support shall be at a distance of not more than 1800 mm. The MS rods shall be hung from the building steel with provision of necessary auxiliary steel members or approved means fixed to the ceiling slab. The auxiliary steel members, hooks, coach screws and all other supporting materials required shall be provided by the bidder. Wherever

in passage, if overhead vertical hanger supports are not possible for the duct length, then channel/beam shall be used, grouted in floor foundation is in the scope of bidders.

IV) Flexible joints shall be provided on the inlet and outlet of each fan and unit to which duct connections are made or where fan sections are isolated from other air handling sections. Connections shall be made from non-combustible heavy glass fabric 1.02 kg/M^2 (30 Oz per sq.yd) double coated with Du Pont's Neoprene (polychloroprene) or Hypalon. Fire standards shall comply with UL214 and NFPA Pamphlet 90A paragraph 2.1.2.3 outlining standards for vibration isolation connectors to duct systems. Minimum 25 mm stack shall be allowed in these connections to isolate transmission of vibration from fan or fan section. The fabric shall either be folded in with the metal or attached with metal collar frames at each end to prevent leakage. The width of the joints from metal edge to metal edge shall be not less than 80 mm and not more than 250 mm. The ends of the ducts or duct and fan connection shall be in line. Canvas or fiberglass shall not be accepted for flexible joints.

V) All curves, bends, offsets and other transformations shall be made for an easy and noiseless flow of air. The throat of every branch duct shall be sized to have the same resistance in the main duct to which the branch duct is connected. All elbows shall have the throat radius of at least seventy five (75) percent of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

VI) Wherever duct passes through wall, all the openings between masonary and duct work shall be neatly caulked or sealed to prevent movement of air from one space to the adjoining space. Where duct passes through the floor, at the lowest point in the elbow a drain trap of 100 mm width across the width of the duct and 50 mm deep shall be provided with suitable gauge valve.

VII) An adequately sized access doors lined with substantial felt edgings shall be provided in the duct work where required. The access doors shall be built up construction, structurally strong and each shall have two rust proof window sash locks of approved type. All doors shall be set out so as to flush with any insulation or plaster finish on the duct.

VIII) Splitters and dampers shall be placed at approved locations for proportional volume control of the system. Splitters and dampers shall be made in 18 gauge GSS of quadrant type with suitable locking device, mounted outside of duct in an accessible location. The metal shall be bent over at each side of the splitter to form a reinforced edge. Each splitter shall be securely attached with a locking device to rods which shall be installed through ducts. On one end of these rods, there shall be locking device with a mark to show the final adjusted position of the splitter

IX) All the plenum chambers or connections to fans, dampers etc, shall be constructed in 18 gauge GSS, supported on 40x40x6 mm MS angle frames. All vertical angles shall be rivetted at approximately 125 mm centres to the casing. 'Pecora' or equivalent caulking compound shall be inserted between the base of angle and all masonary construction to which angles are fastened.

X) Wherever pipe hangers or rods pass through the ducts, light and stream lined casement around the same shall be provided to maintain smooth flow of air.

XI) Supply air grilles shall be of mill finished extruded aluminium construction. Grilles shall be provided with volume control dampers of opposed blade type.

Supply air grilles shall be of double deflection type. All the required steel/wooden frame work for fixing grilles shall be furnished by the bidder.

XII) All air terminals shall be of mill finish extruded aluminium profile construction.

XIII) The proposed ducting scheme, duct sizes, location of supply air grilles etc shown on the enclosed drawings is tentative and subject to finalisation during detailed engineering by the contractor. The bidders shall furnish in their proposal quantities of ducting, duct insulation, supply air grilles. However, these quantities may increase or decrease depending upon the final layout.

XIV) Each branch line shall have dampers to isolate the branch for maintenance purpose.

19.8.8 **Pipe work Valves and Specialities**

i. Unless otherwise specified herein the specification. Piping for sizes smaller than 150 mm NB shall be continuous welded Galvanised steel pipes to IS: 1239 heavy class. Piping for sizes 150 mm and larger shall conform to IS:3589 with minimum 6.35 mm thickness.

ii. Fabricated elbows from pipe (5 piece mitre) shall be furnished for pipe fittings of sizes 200 mm & larger. Locally available long radius (R=1.5D) hot bends with thickness same as that of the pipe having butt welding ends as per ASA B-16.9 shall be furnished for pipe fittings of sizes 150 mm up to 65 mm NB. 3000 # ASA standard forged carbon steel pipe fittings to A-105 Gr.II or IS:1875 Class-2 or approved equal with socket welding ends as per ASA-B-16.11 shall be furnished for pipe fittings of sizes 50 mm NB and smaller.

iii. Unless otherwise specified, all flanges shall be ASA # 150 standard (as applicable) forged carbon steel slipon flanges to A-105 Gr.II or approved equal, faced and drilled to ASA-B-16.5. The pipework flanges shall match with the valves and equipment connections. Hexagonal head machined carbon steel bolts to IS:1367 Class 4.6 or approved equal shall be furnished with hot forged carbon steel hexagonal head nuts to IS:1367 class 4.6. The gaskets shall be 3 mm thick wire inserted red rubber full face gaskets, 150 # ASA standard and drilling details to match with the flanges as required.

iv. In general, all the line joints for sizes 65 mm and larger shall be butt welded and the joints at valves shall be flanged unless otherwise specified. For pipe sizes 50 mm and smaller, the line joints shall be in general socket welded and the joints at valves shall be screwed unless otherwise specified. The joints at equipment and instruments shall be as per manufacturer's drawings.

v. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

vi. All the pipe supports, guides, anchors, turn buckles, rods, hangers with secondary structural steel framing shall be furnished and installed by the Seller. The Seller's support shall utilize the Purchaser's steel as far as practicable. Where additional secondary steel is required for the hangers, these shall be furnished. The secondary auxiliary steel required for the hangers and supports shall be welded to the Purchaser's steel structure as directed by the Engineer. Welding shall not be permitted across the bottom flange of main structural members.

vii. The bidder shall ensure that the location of hangers and supports shall not increase the force and moments on equipment beyond the permissible limits. The anchors shall be designed for rigid fastening to the structure directly or through brackets. As far as possible, attachments of supports brackets to brick walls shall be avoided. All concrete inserts shall be galvanised and shall be installed on the concrete structure where required for fastening supporting devices.

viii. Bolted pipe clamps used for rod hangers shall be of minimum 6 mm thick. Hanger rods shall be 10 mm dia. All hanger components shall be given a shop prime coat of red lead paint.

ix. Upon completion of the installation of all pipework as per approved drawings, the pipe lines section shall be subjected to hydrostatic testing at 1.5 times the design pressure. All joints shall be carefully examined for sweating or leakage and repairs conducted as necessary and the hydrostatic test repeated till its satisfactory completion to the Engineer's satisfaction. After completing the hydrostatic test, the pipe lines shall be drained and flushed several times to ensure complete cleanliness inside the pipes.

x. All the drain piping between the drain connection of each equipment upto the Purchaser's common drain point in the equipment room shall be provided by the Contractor. Necessary seal loops as required shall be incorporated in the drain piping.

xi. The bidder shall submit the circulating water piping layout for Evaporative Cooling System. The quantities of piping, valves and instruments as required shall be included in the proposal. Requirement of pipe fittings, flanges, bolts and nuts, gaskets, couplings and associated accessories shall be estimated by the bidder and included in the scope of supply.

19.8.9 **Valves**

i. Valves shall have full size port and Suitable for horizontal and as well as vertical installation.

ii. Valves for regulating duty shall be of Globe type suitable for controlling through out its lift.

iii. Gate, Globe and stop Check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.

iv. All Safety / relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.

v. Manual gear operator be provided for valves of size 250 NB and above.

vi. All valves with rising stem shall have position indicators.

vii. All valves shall be provided with locking arranement.

viii. All valves for sizes 65 mm and larger shall be 150 # ASA standard, double flanged, cast iron body to IS:210 Gr.260, stainless steel trim, bolted bonnet, bolted gland, rising stem outside scraw and yoke, back seated, ends flanged (PF) faced and drilled to ASA-B-16.5. All valves for sizes 50 mm and smaller shall be 800 class standard forged carbon steel body construction to ASTM A 105 stainless steel trim, union bonnets, rising stem inside screw, renewable seats ends female screwed to IS:554.

ix. The butterfly valves shall be designed as per AWWA C 504 and designed to fit between flanges. The butterfly valves shall be provided with flow control lever, black nitrile rubber integrally moulded seating, disc of aluminium bronze to BS 1400 Gr. AB2/AB1, shafts of stainless steel AISI 410. The butterfly valve shall be rated for 16 bar; body/disc tested at 24 bar and seat at 14 bar.

19.8.15 Gravity Damper

Gravity dampers (self acting dampers) are provided to ensure pressurization of electrical rooms, switch gears rooms, substations etc. Dampers shall be of gravity type designed such as not to allow infiltration of air from outside. The louvers of the dampers shall be freely mounted on Spindles to allow the damper to open freely with the pressure developed in the premises. The damper shall be provided with flange at the inlet, the pressure inside the premises shall be 1-2mm WC.

19.8.16 Fresh Air Unit for Air Conditioning System

The fresh air unit shall consist of:

a) Wall cowl with bird screen, tube axial fan with motor.

b) Pre-filter made up of HDPE and efficiency 90% down to 10 microns and maximum face velocity of 1.75 m/sec. The prefilter used for evaporative coolers and ventilation system shall be of same specification.

c) Fine filter made up of HDPE and efficiency 99.5% down to 5 microns and maximum face velocity 1.25 m/sec.

d) Volume control damper, ducting, fixing frame and necessary supports.

e) Filter frame shall be of aluminium and shall be flanged.

19.9.1 **Water Chilling Plant Control**

i. Microprocessor based controls shall be provided along with facilities to interface with central PLC and to meet the requirement of all system operations and controls.

ii. Water chilling unit control system shall be designed to have a constant chilled water outlet from evaporator at all load condition by means of controlling ON-OFF thermostat (one for each compressor). The closure of liquid line solenoid valve and tripping of compressor at lower water temperature and opening of solenoid valve and starting of compressor at high set point shall be automatic through the thermostat. Between the above set points the compressor capacity shall be controlled automatically.

iii. Water chilling unit shall be equipped with superheat control of water chilling unit through thermostatic expansion valve, which gets its impulse from temperature element connected with suction line after chiller outlet.

iv. High discharge pressure cut-out and oil pressure (OP) differential cut-out shall be of manual reset type and low pressure cut-out shall be automatic reset type. The OP cut-out shall trip the compressor in case of low oil pressure.

v.

vi. On-off toggle switch to close the liquid refrigerant line solenoid valve shall be provided to shut the compressor by the operation of the operation of low pressure cut-out (after the refrigerant has been pumped to the condenser).

vii. Switching of Crank case heaters shall be interlocked with starting and stopping/tripping of compressor motor. Further, the safety thermostat shall switch off the crank-case heater in the event temperature rises above safe limit.

viii. Provision shall also be made for the manual restarting of the compressor.

ix. On-off type anti-freeze thermostats, one for each chiller shall be provided in addition to the controlling on-off thermostat for safety purpose and shall act in the event of failure of on-off thermostat to close the liquid line solenoid valve and also to trip the compressor simultaneously.

x. Compressor starting/running shall be interlocked with the flow switches to be provided at the outlet of each chiller and each condenser and as well as with pressure in the inlet of the condensers. In addition closure or open status of various valves through limit switches shall be used for interlock, alarm and control of Air Conditioning System.

xi. The standby condenser water pumps, standby chilled water pumps, & standby AHU shall be started automatically when the working equipments are stopped/ tripped. Auto/Manual selector Switches and working/ Standby selector switches for the pumps/AHU/fresh air fan shall be provided in the panel.

xii. Closure of fire dampers shall raise an annunciation in the panel.

xiii. There shall be provision in control panel for temperature and flow readings in chilled water inlet and outlet line across AHUs to monitor the air conditioning load of each area.

xiv. Operation of Air conditioning system shall be interlocked with the required minimum pressure and temperature of cooling water at inlet to the condenser through pressure and temperature transmitters. Status indication of Station auxiliary Cooling water pumps & associated cooling towers shall be provided in the control panel of air conditioning plant.

d) **Air Handling Unit chilled water type**

i. Control of the inside room temperature and humidity shall be by controlling the chilled water flow by means of motor operated three way modulating valve and the modulating valve shall get its signal from the temperature sensor.

ii. Humidistat located in the return air duct shall actuate the pan humidifier to obtain the desired degree of humidification.

iii. Separate Humidistat and thermostats shall be provided and interlocked in steps with winter heater / re-heater / strip heaters for monsoon and winter re-heating or heating as the case may be.

iv. Heater banks shall be interlocked with the running of AHU, temperature of return air, humidity of return air and safety thermostat (Geyserstat located in front of the each heater in the supply air duct)

v. AHU shall be started either from its local panel or from the main control panel of AC system by means of Remote/Manual selector switches.

vi. The closure of fire dampers, automatic tripping of AHU fans and fresh air fans shall be interlocked with Bidder's fire Detection System.

vii. Each AHU shall be provided with temperature indictors and flow indicator in the chilled water piping inlet and outlet to monitor the air-conditioning load of each area.

viii. Miscellaneous control requirements

ix. Separate emergency local stop push button shall be provided for each pump, compressor, fans etc. of AC system.

x. Lamps shall be provided for indicating the status of each pump, compressor, fans etc. of AC system in the main and local panel.

xi. All the annunciation related to failure of equipments, tripping of equipments, source of failure / reason due to which the equipment is stopped / tripped, low & high limits of parameters such as level, temperature, pressure drop, pressure etc shall be provided for each pump, fan, compressor, AHU, PAC etc. in the respective panel.

xii. Fully wired, twenty percent (20%) spare annunciation windows shall be provided in all the panels.

19.8.19 Bidders shall ensure that the guaranteed control room noise level is maintained and the units are designed for achieving the same. The vibration level of the units shall be within limits and vibration isolation shall be achieved by providing suitable spring type or pad type (or combination) vibration isolators for ventilation system equipment (centrifugal fans) and airconditioning system equipment (A/c units, AHUs, Cooling Towers, Pumps etc.)

SECTION: I

SUB-SECTION: C 2
PART-B

CUSTOMER SPECIFICATION
PROJECT SPECIFIC GENERAL REQUIREMENTS

8.03.01 **Instruction Manuals**

The Bidder shall submit to the Owner, draft Instruction Manuals for all the equipment covered under the Contract by the end of one year from the date of his acceptance of the Letter of Award. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project. After finalization and approval of the Owner the Instruction Manuals shall be submitted as indicated in Annexure-I. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Owner. The Instruction Manuals shall comprise of the following.

Erection Manuals

The erection manuals shall be submitted atleast three (3) months prior to the commencement of erection activities of particular equipment/system. The erection manual should contain the following as a minimum.

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

e) List of tool, tackles, heavy equipment like cranes, dozers, etc.

f) Bill of Materials

g) Procedure for erection.

h) General safety procedures to followed during erection/installation.

i) Procedure for initial checking after erection.

j) Procedure for testing and acceptance norms.

k) Procedure / Check list for pre-commissioning activities.

l) Procedure / Check list for commissioning of the system.

m) Safety precautions to be followed in electrical supply distribution during erection

Operation & Maintenance Manuals

i. The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble and adjust all parts of the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant / equipment including, operation, maintenance, dismantling and repair including periodical activities such as chemical cleaning of the generator. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Owner.

ii. If after the commissioning and initial operation of the plant, the manuals require any modification / additions / changes, the same shall be incorporated and the updated final instruction manuals shall be submitted to the Owner for records.

iii. A separate section of the manual shall be for each size/ type of equipment and shall contain a detailed description of construction and operation, together with all relevant pamphlets and drawings.

iv. The manuals shall include the following :

a) List of spare parts along with their drawing and catalogues and procedure for ordering spares.

b) Lubrication Schedule including charts showing lubrication checking, testing and replacement procedure to be carried daily, weekly, monthly & at longer intervals to ensure trouble free operation.

c) Where applicable, fault location charts shall be included to facilitate finding the cause of maloperation or break down.

v. Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. system/equipment/assembly/sub-assembly - wise required for the complete plant.

vi. On completion of erection, a complete list of bearings / equipment giving their location, and identification marks etc. shall also be furnished to the Owner indicating lubrication method for each type/category of bearing.

8.03.02 **Plant Handbook**

The Bidder shall submit to the Owner a preliminary plant hand book preferably in A-4 size sheets which shall contain the design and performance data of various plants, equipment and systems covering the complete project including

1. Design and performance data.
2. Process & Instrumentation diagrams.
3. Single line diagrams.
4. Sequence & Protection Interlock Schemes.
5. Alarm and trip values.
6. Performance Curves.
7. General layout plan and layout of main plant building and auxiliary buildings.
8. Important Do's & Don't's

The plant handbook shall be submitted within twelve (12) months from the date of award of contract. After the incorporation of Owner's comments, the final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

8.03.03 **Project Completion Report**

The Bidder shall submit a Project Completion Report at the time of handing over the plant.

8.03.04 **Drawings**

(a.) All documents submitted by the Bidder for Owner's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I. The soft copies to be supplied shall be either in CDs, or through direct transfer via E-mail, etc. depending upon the nature/volume/size of the document. The drawings submitted for approval could be in the Image form.

(b.) Final copies of the approved drawings shall be submitted on CD-ROM along with the requisite number of hard copies as per Annexure-I.

(c.) The completed plant documentation with equipment drawings, data sheets, P&ID, BOQ, schematics, logic diagrams, test reports and quality plan, etc. shall be furnished to Owner.

(d.) All documents/text information shall be in latest version of MS Office.

(e.) All drawings submitted by the Bidder including those submitted at the time of bid shall be in sufficient detail indicating the type, size, arrangement, weight of each component for packing and shipment, the external connection, fixing arrangement required, the dimensions required for installation and interconnections with other equipment and materials, clearance and spaces required between various portions of equipment and any other information specifically requested in the drawing schedules.

(f.) Each drawing submitted by the Bidder (including those of sub-vendors) shall bear a title block at the right hand bottom corner with clear mention of the name of the Owner, Consultant, name of the Project, system designation, the specifications title, the specification number, drawing/document number and revisions. If standard catalogue pages are submitted the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(g) **As Built Drawings**
After final acceptance of individual equipment/system by the Owner, the Bidder will update all original drawings and documents for the equipment/ system to “as built” conditions.

(h.) Drawings must be checked by the Bidder in terms of its completeness, data adequacy and relevance with respect to Engineering schedule prior to submission to the Owner. In case drawings are found to be submitted without proper endorsement for checking by the Bidder, the same shall not be reviewed and returned to the Bidder for resubmission. The Bidder shall make a visit to site to see the existing facilities and understand the layout completely and collect all necessary data/drawings at site which are needed as an input to the engineering. The Bidder shall do the complete engineering including interfacing and integration of all his equipment, systems & facilities within his scope of work as well as interface engineering & integration of systems, facilities, equipment & works under Owner’s scope and submit all necessary drawings/ documents for the same.

(i.) The Bidder shall submit adequate prints of drawing/data/document for Owner’s review and approval. The Owner shall review the drawings and return one (1) copy to the Bidder authorizing either to proceed with manufacture or fabrication, or marked to show changes desired. When changes are required, drawings shall be re-submitted promptly, with revisions clearly marked, for final review. Any delays arising out of the failure of the Bidder to submit/rectify and resubmit in time shall not be accepted as a reason for delay in the contract schedule.

(j.) All engineering data submitted by the Bidder after final process including review and approval by the Owner shall form part of the contract doc. and the entire works covered under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Owner in writing.

8.10.00 **Lubricants, Servo Fluids and Chemicals**

8.10.01 The Bidder's scope includes all the first fill and one year's topping, requirements of consumables such as oils, lubricants including grease, servo fluids, gases and essential chemicals etc. Consumption of all these consumables during the initial operation and final filling after the initial operation shall also be included in the scope of the Bidder. Bidder shall also supply a quantity not less than 10% of the full charge of each variety of lubricants, servo fluids, gases, chemicals etc. used which is expected to be utilised during the first year of operation. This additional quantity shall be supplied in separate Containers.

8.10.02 As far as possible lubricants marketed by the Indian Oil Corporation shall be used. The variety of lubricants shall be kept to a minimum possible.

Detailed specifications for the lubricating oil, grease, gases, servo fluids, control fluids, chemicals etc. required for the complete plant covered herein shall be furnished. On completion of erection, a complete list of bearings/ equipment giving their location and identification marks shall be furnished to the Owner along with lubrication requirements.

8.11.00 **Lubrication**

8.11.01 Equipment shall be lubricated by systems designed for continuous operation. Lubricant level indicators shall be furnished and marked to indicate proper levels under both standstill and operating conditions.

8.12.00 **Material of Construction**

8.12.01 All materials used for the construction of the equipment shall be new and shall be in accordance with the requirements of this specification. Materials utilized for various components shall be those which have established themselves for use in such applications.

8.13.00 **Rating Plates, Name Plates & Labels**

8.13.01 Each main and auxiliary item of plant including instruments shall have permanently attached to it in a conspicuous position, a rating plate of non-corrosive material upon which shall be engraved manufacturer's name, equipment, type or serial number together with details of the ratings, service conditions under which the item of plant in question has been designed to operate, and such diagram plates as may be required by the Owner.

8.13.02 Each item of plant shall be provided with nameplate or label designating the service of the particular equipment. The inscriptions shall be approved by the Owner or as detailed in appropriate section of the technical specifications.

8.13.03 Such nameplates or labels shall be of white non-hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breakers, starters, etc. of transparent plastic material with suitably coloured lettering

engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

8.13.04 Items of plant such as valves, which are subject to handling, shall be provided with an engraved chromium plated nameplate or label with engraving filled with epoxy. The name plates for valves shall be marked in accordance with MSS standard SP-25 and ANSI B 16.34 as a minimum.

8.13.05 Hanger/ support numbers shall be marked on all pipe supports, anchors, hangers, snubbers and restraint assemblies. Each constant and variable spring support shall also have stamped upon it the designed hot and cold load which it is intended to support. Suitable scale shall also be provided to indicate load on support/hanger.

8.13.06 Valves, steam traps and strainers shall be identified by Owner's tag number of a metal tap permanently attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

8.13.07 Safety and relief valves shall be provided with the following :

(a.) Manufacturer's identification.

(b.) Nominal inlet and outlet sizes in mm.

(c.) Set pressure in Kg/cm2 (abs).

(d.) Blowdown and accumulation as percentage of set pressure.

(e.) Certified capacity in Kg of saturated steam per hour or in case of liquid certified capacity in litres of water per minute.

8.13.08 All such plates, instruction plates, etc. shall be bilingual with Hindi inscription first, followed by English. Alternatively, two separate plates one with Hindi and the other with English inscriptions may be provided.

8.13.09 All segregated phases of conductors or bus ducts, indoor or outdoor, shall be provided with coloured phase plates to clearly identify the phase of the system

8.14.00 **Tools and Tackles**

The Bidder shall supply with the equipment one complete set of all special tools and tackles and other instruments required for the erection, assembly, disassembly and proper maintenance of the plant and equipment and systems (including software). These special tools will also include special material handling equipment, jigs and fixtures for maintenance and calibration / readjustment, checking and measurement aids etc. A list of such tools and tackles shall be submitted by the Bidder alongwith the offer.

The price of each tool / tackle shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Bidder shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Bidder should bring his own tools and tackles. All the tools and tackles shall be of reputed make acceptable to the Owner.

8.15.00 **Welding**

8.15.01 If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipment to be per formed by others the requirements shall be submitted to the Owner in advance of commencement of erection work.

8.16.00 **Colour Code for all Equipment/ Pipings/ Pipe Services**

8.16.01 All equipment/ piping/ pipe services are to be painted by the Bidder in accordance with Owner's standard colour coding scheme, which will be furnished to the Bidder during detailed engineering stage.

8.17.00 **Protection and Preservative Shop Coating**

8.17.01 **Protection**

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either metallic or a nonmetallic protection device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather, should also be properly treated and protected in a suitable manner. All primers/paints/coatings shall take into account the hot humid, corrosive & alkaline, subsoil or overground environment as the case may be.

8.17.02 **Preservative Shop Coating**

All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall be treated beforehand and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scales, oxides and other coatings and prepared in the shop. The surfaces that are to be finish-painted after installation or require corrosion protection until installation, shall be shop painted with atleast two coats of primer.

Transformers and other electrical equipment if included shall be shop finished with one or more coats of primer and two coats of high grade epoxy. The finished colors shall be as per manufacturer's standards, to be selected and specified by the Owner at a later date.

8.17.03 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 degrees Celsius shall be selected by the Bidder after obtaining specific approval of the Owner regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperature higher than 95 degrees Celsius and such primer shall also be subject to the approval of the Owner.

8.17.04 All other steel surfaces which are not to be painted shall be coated with suitable rust preventive compound subject to the approval of the Owner.

8.17.05 All piping shall be cleaned after shop assembly by shot blasting or other means approved by the Owner. Lube oil piping or carbon steel shall be pickled.

8.17.06 Painting for Civil structures shall be done as per relevant part of technical specification.

9.00.00 QUALITY ASSURANCE PROGRAMME

9.01.00 The Bidder shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Bidder's works or at his sub-Bidder's premises or at the Owner's site or at any other place of work are in accordance with the specifications. Such programs shall be outlined by the Bidder and shall be finally accepted by the Owner/authorized representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-9001. A quality assurance programme of the Bidder shall generally cover the following:

(a.) His organization structure for the management and implementation of the proposed quality assurance programme

(b.) Quality System Manual
(c.) Design Control System

(d.) Documentation and Data Control System

(e.) Qualification data for bidder's key personnel.

(f.) The procedure for purchase of materials, parts, components and selection of sub-Bidder's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.

(g.) System for shop manufacturing and site erection controls including process, fabrication and assembly.

(h.) Control of non-conforming items and system for corrective actions and resolution of deviations.

(i.) Inspection and test procedure both for manufacture and field activities.

(j.) Control of calibration and testing of measuring testing equipment.

(k.) System for Quality Audits.

(l.) System for identification and appraisal of inspection status.

(m.) System for authorising release of manufactured product to the Owner.

(n.) System for handling, storage and delivery.

(o.) System for maintenance of records, and

(p.) Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component.

9.02.00 **General Requirements - Quality Assurance**

9.02.01 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme duly approved by the Owner. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to Owner for approval. Schedule of finalisation of such quality plans will be finalised before award. Monthly progress reports on MQP/FQP submission/approval shall be furnished.

9.02.02 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's/ Sub-Bidder's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. Compact Disc or E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

9.02.03 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's "Site Quality Control Organisation", during various stages of site activities starting from receipt of materials/equipment at site.

9.02.04 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference

documents/standards etc. will be subject to Owner's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Owner shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Owner's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Owner in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner along with technical justification for approval and dispositioning.

9.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to predespatch final inspection including verification of records of all previous tests/inspections by Owner's Project Manager/Authorised representative and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).

9.02.06 All material used for equipment manufacture including casting and forging etc. shall be of tested quality as per relevant codes/standards. Details of results of the tests conducted to determine the mechanical properties; chemical analysis and details of heat treatment procedure recommended and actually followed shall be recorded on certificates and time temperature chart. Tests shall be carried out as per applicable material standards and/or agreed details.

9.02.07 The Bidder shall submit to the Owner Field Welding Schedule for field welding activities in the enclosed format No.: QS-01-QAI-P-02/F3. The field welding schedule shall be submitted to the Owner along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least ninety days before schedule start of erection work at site.

9.02.08 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the Owner.

All welding/brazing procedures shall be submitted to the Owner or its authorised representative for approval prior to carrying out the welding/brazing.

9.02.09 All brazers, welders and welding operators employed on any part of the contract either in Bidder's/sub-Bidder's works or at site or elsewhere shall be qualified as per ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the Owner.

9.02.10 Welding procedure qualification & Welder qualification test results shall be furnished to the Owner for approval. However, where required by the Owner, tests shall be conducted in presence of Owner/authorised representative.

9.02.12 Unless otherwise proven and specifically agreed with the Owner, welding of dissimilar materials and high alloy materials shall be carried out at shop only.

9.02.13 No welding shall be carried out on cast iron components for repair.

9.02.14 All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

9.02.15 All non-destructive examination shall be performed in accordance with written procedures as per International Standards, The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job.

9.02.19 The Bidder shall carry out an inspection and testing programme during manufacture in his work and that of his sub-Bidder's and at site to ensure the mechanical accuracy of components, compliance with drawings, conformance to functional and performance requirements, identity and acceptability of all materials parts and equipment. Bidder shall carry out all tests/inspection required to establish that the items/equipment conform to requirements of the specification and the relevant codes/standards specified in the specification, in addition to carrying out tests as per the approved quality plan.

9.02.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Owner to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above shall in no way limit the liabilities and responsibilities of the Bidder in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

9.02.21 For all spares and replacement items, the quality requirements as agreed for the main equipment supply shall be applicable.

9.02.22 Repair/rectification procedures to be adopted to make the job acceptable shall be subject to the approval of the Owner/ authorised representative.

9.02.23 Burn in and Elevated Temperature Test Requirement for Electronics Solid State Equipment

All solid state electronic systems/equipment shall be tested as a complete system/equipment with all devices connected for a minimum of 168 hours (7 Days) continuously under energized conditions prior to shipment from manufacturing works, as per the following cycle.

Elevated Temperature Test Cycle

During the elevated temperature test which shall be for 48 hours of the total 168 hours of testing, the ambient temperature shall be maintained at 50 deg.C. The equipment shall be interconnected with devices which will cause it to repeatedly perform all operations it is expected to perform in actual service with load on various components being equal to those which will be experienced in actual service.

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and

inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at 50 deg.C.

Burn in Test Cycle

The 48 hours elevated temperature test shall be followed by 120 hours of burn in test as above except that the temperature shall be reduced to the ambient temperature prevalent at that time.

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

In case the Bidder/ sub-Bidder is having any alternate established procedure of eliminating infant mortile components, the detail procedures followed by the Bidder/ sub- Bidder along with the statistical figures to validate the alternate procedure to be forwarded.

The Bidder/Sub-Bidder shall carry out routine test on 100% item at Bidder/sub-Bidder's works. The quantum of check/test for routine & acceptance test by Owner shall be generally as per criteria/sampling plan defined in referred standards. Wherever standards have not been mentioned quantum of check/test for routine / acceptance test shall be as agreed during detailed engineering stage.

10.03.00 **Guarantee Tests**

a) The final test as to prove the Functional Guarantees shall be conducted at Site by the Bidder in presence of the Owner. The Bidder's Commissioning, Start-up Purchaser shall make the unit ready to conduct such test. Such test will be commenced and completed as per schedule indicated in Vol I GCC

b) These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the functional guarantee.

c) For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Owner shall be used. The numbers and location of the instruments shall be as per the specified test codes. In addition the values of parameters shall be logged from the information system provided under Owner's Distributed Digital Control Monitoring and Information system. Test will be conducted at specified load points.

d) Any special equipment, tools and tackles required for the successful completion of the Guarantee Tests shall be provided by the Bidder, free of cost.

e) The Guarantee tests and specific tests to be conducted on equipment have been brought out in detail elsewhere in the specification.

11.00.00 TAKING OVER

Upon successful completion of Initial Operations and all the tests other than guarantee tests conducted to the Owner's satisfaction, the Owner shall issue to the Bidder a Taking over Certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be with held nor will the Owner delay the issuance thereof, on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Bidder of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

13.00.00 SAFETY ASPECTS DURING CONSTRUCTION AND ERECTION

In addition to the requirements given in Erection Conditions of Contract (ECC) the following shall also cover:

(a.) Working platforms should be fenced and shall have means of access.

(b.) Ladders in accordance with Owner's safety rules for construction and erection shall be used. Rungs shall not be welded on columns. All the stairs shall be provided with handrails immediately after its erection.

14.00.00 NOISE LEVEL

The equivalent 'A' weighted sound pressure level measured at a height of 1.0 m above floor level in elevation and at a distance of one (1) meter horizontally from the nearest surface of any equipment / machine, furnished and installed under these specifications, expressed in decibels to a reference of 0.0002 microbar, shall not exceed 85 dBA except for

(a.) Safety valves and associated vent pipes for which it shall not exceed 105 dBA.

(b.) Regulating drain valves in which case it shall be limited to 90 dBA.

(c.) TG unit in which case it shall not exceed 90 dBA.

(d.) For HP-LP bypass valves and other intermittently operating control valves, the noise level shall be within the limit of 85 dBA.

15.00.00 PACKAGING AND TRANSPORTATION

All the equipment & spares shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. Each spare shall be clearly marked or labeled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such a case and other packages must be suitably marked and numbered for the purpose of identification. All cases, containers or packages, are liable to be opened for such examination as may be considered reasonable by the Engineer. In case of equipment supplied with grease/lubricants from imported origin, the supplied shall clearly indicate the indigenous equivalent of the grease/lubricant and source of supply so as to enable the Owner to procure these items from indigenous sources. While packing all the materials, the limitation from the point of view of the sizes of railway wagons available in India should be taken account of. The Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. The Bidder shall ascertain the availability of Railway wagon sizes from the Indian Railways or any other agency concerned in India well before effecting dispatch of equipment. Before dispatch it shall be ensured that complete processing and manufacturing of the components is carried out at shop, only restricted by transport limitation, in order to ensure that site works like grinding, welding, cutting & pre-assembly to bare minimum. The Owner's Inspector shall have right to insist for completion of works in shops before dispatch of materials for transportation.

16.00.00 ELECTRICAL ENCLOSURE

All electrical equipment and devices, including insulation, heating and ventilation devices shall be designed for ambient temp. and a maximum relative humidity as specified elsewhere in the spec.

ANNEXURE-III

	Project : **Stage :** **Package :** **Supplier :** **Bidder No. :**			**LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL** **SUB-SYSTEM:**				**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**		
S. N.	**Item**	**QP/ Insp. Cat.**	**QP No.**	**QP Sub. Schedule**	**QP approval schedule**	**Proposed sub-supplier**	**Place**	**Sub-suppliers approval status/ category**	**Sub-supplier Details submission schedule**	**Remarks**

LEGENDS

1. SYSTEM SUPPLIER/SUB-SUPPLIER APPROVAL STATUS CATEGORY (SHALL BE FILLED BY the Owner)

A – For these items proposed vendor is acceptable to the Owner. To be indicated with letter "A" in the list alongwith the condition of approval, if any.

DR – For these items "Detailed required" for the Owner review. To be identified with letter "DR" in the list.

NOTED – For these items vendors are approved by Main Supplier and accepted by the Owner without specific vendor approval from the Owner. To be identified with "NOTED.'

2. **QP/INSPN CATEGORY**:

CAT-I : For these items the Quality Plans are approved by the Owner and the final acceptance will be on physical inspection witness by the Owner.

CAT-II : For these items the Quality Plans approved by the Owner. However no physical inspection shall be done by the Owner. The final acceptance by the Owner shall be on the basis review of documents as per approved QP.

CAT-III : For these items Main Supplier approves the Quality Plans. The final acceptance by the Owner shall be on the basis certificate of conformance by the main supplier.

UNITS/WORKS : Place of manufacturing Place of Main Supplier of multi units/works.

ANNEXURE-V

	Project : **Stage :** **Bidder :** **Bidder No. :** **System :**	**FIELD WELDING SCHEDULE** **(To be raised by the Bidder)** **Welding Code: ……**	**DOC. NO.:** **REV. NO.:** **DATE :** **PAGE : OF**

Sl. No.	**DRG No. for Weld Location and Identification mark**	**Description of parts to welded**	**Matl. Spec.**	Dimensions		**Process of welding**	**Type of Weld**	**Electrode filler spec.**	**WPS. No.**	**Min. pre-heat**	**Heat treatment**		**NDT method/ Quantum**	**REF**		**Remarks**
											Temp.	**Holding time**		**Spec. No.**	**ACC Norm Ref.**	

NOTES:

SIGNATURE

ANNEXURE-VI

MFGR.'s LOGO	MANUFACTURER'S NAME AND ADDRESS	MANUFACTURING QUALITY PLAN ITEM : SUB-SYSTEM:	QP NO.: REV.NO.: DATE: PAGE: …. OF….	PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
										M	C	N	
1.	2.	3.	4.	5.	6.	7.	8.	9.	D *	** 10.			11.

MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER **C:** SUPPLIER/NOMINATED INSPECTION AGENCY, **N**: THE OWNER	FOR THE	DOC. NO.: REV…… CAT…..		

SIGNATURE	**P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** THE OWNER SHALL IDENTIFIED IN COLUM "N"	**OWNER USE**	**REVIEWED BY**	**APPROVED BY**	**APPROVAL SEAL**

ANNEXURE-VII

MFGR.'s LOGO	SUPPLIER'S NAME AND ADDRESS	FIELD QUALITY PLAN		PROJECT : PACKAGE : CONTRACT NO. : MAIN-SUPPLIER:
		ITEM : SUB-SYSTEM :	QP NO.: REV.NO.: DATE: PAGE: …. OF….	

SL. NO	ACTIVITY AND OPERATION	CHARACTERISTICS / INSTRUMENTS	CLASS# OF CHECK	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	D*	REMARKS
1.	2.	3.	4.	5.	6.	7.	8.	9.		10.

		LEGEND: * **RECORDS**, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS #: A = CRITICAL, B=MAJOR, C=MINOR;**		DOC. NO.: REV……	
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR THE		

SIGNATURE	**'A'** SHALL BE WITNESSED BY THE OWNER FQA, **'B'** SHALL BE WITNESSED BY OWNER'S ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY ERECTION SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)	**OWNER USE**	**REVIEWED BY**	**APPROVED BY**	**APPROVAL SEAL**

14.0 OWNER'S REPRESENTATIVE AT SITE:

14.1 SE/ Projects, "2 x 660 MW Ennore SEZ Supercritical Thermal Power Project at Ash Dyke of NCTPS" shall be the Owner's representative at site and shall act as an In-charge for all the site works. The contractor's Resident Engineer shall report to him for all the day to day works.

15.0 CONSIGNEE:

All materials shall be consigned to:
SE/ Projects
Tamil Nadu Generation and Distribution Corporation
Ennore SEZ Supercritical TPP

16.0 PAINTS, CONSUMABLES:

16.1 Pursuant to the Clause No. 25.0 of Section 3, Volume I, it shall be the responsibility of the contractor to supply all the paints as required.

16.2 It shall be the responsibility of The Contractor to supply all consumables like, grease, lubricating oils, all chemicals, ink & graphs for recorders etc., up to satisfactory completion of trial operation and three months thereafter. The Contractor shall also arrange any additional quantities required specifically for the Performance Guarantee Test. Contractor shall furnish specifications of all such consumable to enable the Owner to purchase his future requirements well in advance.

18.0 OPERATION AND MAINTENANCE MANUALS:

18.1 For all the equipments supplied by the Contractor, he shall submit to the Owner ten sets of the O&M manuals. The manual shall contain the operational features of the equipment, DOs & DON'Ts, trouble shooting, maintenance schedules for preventive maintenance, detail dimensional drawings, cross sectional drawings, method of assembly etc. to make the Owner's staff acquainted with the equipment as well as to enable them to operate and maintain the same in prescribed manner. Manuals shall contain all information for ordering of the spares, like part name, part no., Drawing/ material Specifications, address of the supplier with phone no. & fax no. etc. Contractor shall ensure that these O&M manuals are made available to the Owner well before starting of initial trials of equipment.

18.2 ERECTION MANUALS:

18.2.1 In order to enable the engineers of the Owner to supervise the works properly, Contractor shall furnish five copies of erection manuals depicting therein the erection procedure, special precautions to be taken, various clearance to be maintained, erection checks and tests to be carried out before the equipment is put to initial trials.

26.0 FINAL ACCEPTANCE:

26.1 In case Performance Guarantee Test cannot be carried out at specified time due to reasons attributable to Owner, the Plant shall be taken over 180 days after the intimation from the Contractor provided the Owner is satisfied about his readiness for conducting the Performance Guarantee Test. In such case, the Owner shall give an adhoc final acceptance certificate for the purpose of triggering the Guarantee/Defect Liability period which will be subject to revision based on actual PG test results. In such an eventuality, the Owner shall give a notice to the Contractor of his readiness to give necessary inputs to enable the Contractor to do the Performance Guarantee Test, in which case the Contractor shall arrange the Performance Guarantee Test within 30 days on receipt of such notice without any additional financial implication to the Owner.

26.2 26.2 On conducting the Performance Guarantee Test, if it is established to the satisfaction of the Owner that the equipment is performing as specified in the Technical Specifications, the Owner shall issue to the Contractor a final acceptance certificate indicating the date from which the equipment has been taken over.

26.3 26.3 Such a certificate shall be given within 30 days after satisfactory completion of the performance guarantee test and PG test results are furnished by the Contractor to prove the achievement of the assured PG values. Owner shall not delay the issuance thereof on account of minor omissions or defects which do not affect the safe and reliable operation and/or cause any risk to the equipment. Such certificate shall, however, not relieve the Contractor of any of his obligations which otherwise survive by the terms and conditions of the contract.

****

SECTION: I

SUB-SECTION: C 2C

CUSTOMER SPECIFICATIONS

PAINTING SPECIFICATIONS

CHAPTER - 6

PAINTING

1.0 SCOPE

This section defines the technical requirements for surface preparation, selection and application of paints on equipment, vessels, machinery, piping, ducts etc. However, manufacturers shall follow their standard procedures for painting their equipment. The bidder shall submit a detailed painting procedure for approval of owner/ owner's representative after the award of contract.

The following surface and material shall require painting:

a. All un-insulated carbon steel and alloy steel equipment like columns, vessels, storage tanks, pumps, heat exchangers etc.
b. All un-insulated carbon steel and low alloy piping, fitting and valves (including painting of identification marks).
c. All pipe structural steel supports, walkways, platforms, handrails, ladders etc.

The following surfaces and materials shall not require painting :

a. Non-ferrous materials
b. Austentic stainless steel
c. Plastic and / or plastic coated materials
d. Insulated surface of equipment and pipes except color coating wherever required.
e. Painted equipment like blowers, pumps, valves etc. with finishing coats in good condition and with matching color code.

2.0 CODES AND STANDARDS

Painting of equipment shall be carried out as per the specifications indicated below and shall conform to the relevant IS specification for the material and workmanship.

The following Indian Standards may be referred to for carrying out the painting job :

IS:5	:	Colours for ready mixed paints and enamels
IS:1303	:	Glossary of terms relating to paints
IS:2379	:	Colour code for identification of pipelines
IS:1477	:	Code of practice for painting of ferrous metals in buildings (Parts I & II)
IS:2524	:	Code of practice for painting of non-ferrous metals in buildings (Parts I & II)
IS:2395	:	Code of practice for painting of concrete, masonry and plaster surfaces (Parts I & II)

IS:2338	:	Code of practice for finishing of wood and wood based materials (Parts I & II)
IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting.
IS:2074	:	Ready mixed paint, air drying, red Oxide Zinc Chrome, priming
IS:104	:	Ready mixed paint, brushing, Zinc Chrome, priming
IS:2932	:	Enamel Synthetic exterior (a) Undercoating (b) finishing
IS:4682	:	Code of practice for lining of vessels & equipment
SIS 559000	:	Swedish standard for blasting
ISO 8504-2	:	Preparation of steel substrates before application of paints and related products. Surface preparation methods Part 2 Abrasive blast cleaning
ISO 8501-1	:	Preparation of steel substrates before application of paints and related products. Visual assessment of surface cleanliness. Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
SIS 05 5800	:	Surface preparation by acid pickling
SSPC SP08	:	Surface preparation by acid pickling
IS 2629	:	Recommended practice for hot dip galvanizing of iron and steel
ASTM A780	:	Standard practice for repair of damaged galvanized coatings
SSPC	:	Steel structures painting council
NACE	:	National association of Corrosion Engineers
DIN	:	Deutsehes Institute for Normung
BS	:	British Standard
ASTM	:	American Society for Testing material
AWWA	:	American Water works association

3.0 SURFACE PREPARATION

The surface shall be prepared in a manner suitable for coatings. Chemical derusters or rust converters shall not be applied. Acid cleaning is subject to approval of Purchaser/ Purchaser's representative.

3.1 BLASTING

The surface of the part/ component shall be blasted before the coating material is applied.
Compressed air supply for blast cleaning shall be free of water and oil. Air compressors shall not be allowed to deliver air above 1100C. Blasting activity shall be performed at temperatures 30C above due point and substrata temperature between 50C & 500C and relative humidity not exceeding 85% shall be maintained during painting. Necessary safety precautions for equipment and operator shall be adhered to and shall comply with applicable laws, regulations, ordinances etc., of the local authority, state or the nation pertains to the work.

Abrasive used for blast cleaning carbon steel and alloy steel shall be as per ISO 8504-2 and SSPC painting manual. Suggested abrasives are chilled iron grit, shot steel, malleable iron grit and shots of non metallic abrasive (aluminum oxide, copper slag, garnet etc.).
The grade of blasting shall be performed in line with the approved painting scheme.
The nature, quality and grain size of abrasives and the parameter of their use are to be chosen to obtain the required surface profile depth and cleanliness.
Surfaces prepared for coating shall be coated the same day and before any visible rusting occurs (the time elapsed between blast cleaning and commencement pf painting shall under no circumstances exceed 4 hours, but in any case must commence before signs of degradation occur).

The grades of surface finish

	ISO 8501-1	SIS 055900	SSPC	NACE
White metal	Sa3	Sa3	SP5	1
Near White metal	Sa 2½	Sa 2½	SP10	2
Commercial Blast	Sa2	Sa2	SP6	3
Brush off blast	Sa1	Sa1	SP7	4

Unless otherwise specified in the documents, the surface shall satisfy the following requirements after blasting
(a) Blasting according to SIS 055900, Grade Sa 2½

Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer coat shall be 15-25 µm.

3.2 Manual Rust Removal

Manual rust removal shall be allowed for welded zones and for touching up installed components.

3.3 Cleaning

Removal of impurity

	Impurity	Removal
a)	Dust, Loose deposits	Vacuum cleaning, brushing
b)	Adhesive deposits	Power brushing
c)	Oils, greasy impurities	Wet Blasting, Use of Detergent Additives by agreement
d)	Salt deposits	Rinsing
e)	Markings (eg felt up pen)	Organic solvents to manufacturer's specifications eg Trichloro trifluoro ethane and solvents containing acetone (renew solvent and rag frequently)

3.4 Acid Pickling

Prior to galvanizing the surface preparation shall be done by acid pickling as per SSPC-SP-08.

4.0 PROCESSING

4.1 General
Application Conditions

The primer shall be applied to properly prepared surfaces only. The specifications of the coating material manufacturers shall be observed. The minimum temperature shall be + 5^0C and the relative humidity shall not exceed 80%. The temperature of the work piece shall be at least 3^0C above dew point.

4.2 Application Procedure

The primer shall be applied by means of brush or by spary. The top coats shall be applied by means of brush, roller or spray.

At points where coating application is interrupted, the individual layers shall be adequately stepped to ensure proper layer sequence when coating operations are resumed.

4.3 Touching Up

Before each layer is applied, previous coating shall be touched up where necessary by way of rust removal and cleaning according coating manufacturers specification. The final top shall be reapplies completely.

4.4 Uncoated Surfaces

Moving parts of machines (e.g stems, shafts, sliding and locating bearings), nameplates, instruments and sealing surface shall not be coated. Welds shall be left free of coating upto a distance of 30 mm on each side of the weld edge until erection and weld examinations, if any, have been completed.

4.5 Bond Strength

The pill off stress determined using the pull off test method for adhesion shall not be less than 1.5 N/mm2, according to ISO 4624.

5.0 SURFACE CONDITIONS OF COATING SURFACES

The coating surface shall have a uniform film thickness, shade and gloss and shall be free from inclusions, sags and wrinkles.

6.0 COATING SYSTEMS

6.1 General Requirements for Coating Systems

Coating materials according to SSPC, BS 5493 or DIN 55 928 shall be used. Intermediate coats are to be pigmented with micaceous iron oxide. The materials shall be matched with each other so that they are compatible. Coatings deviating this

specification shall be subject to approval. Standards of surface preparation and painting shall give a time to first maintenance of 10 years.

The colour and gloss of top coats shall be in accordance with sub clause suggested colour codes for painting (Sub Clause 6.8)

6.2 Standard Coating System (External Coatings)

(a) Steel Surfaces

(i) All steel structures shall receive two primer coats and two sandwich coat of MIO Epoxy paint and one finish coat of painting. First coat of primer shall be given in shop after fabrication before dispatch to erection site after surface preparation as described below. The second coat of primer shall be applied after erection and final alignment of the erected structures. Two intermediate coats and one finished coat shall also be applied after erection.

(ii) Steel surface which is to be painted shall be cleaned of dust and grease and the heavier layers of rust shall be removed by chipping prior to actual surface preparation. The surface shall be abrasive blasted as explained in clause 3.1 to Sa 2½ finish as per SIS05-5900. Primer paint shall be Zinc Silicate of approved brand. Dry film thickness of each primer shall be 60 microns.

(iii) Two intermediate MIO Epoxy paint, and one top polyurethane coating of approved brand shall be applied. Dry film thickness of each intermediate coat shall be 90 microns and top polyurethane coating shall be 30 microns. The under coat and finish coat shall be of different tint to distinguish the same from finish paint. The total dry film thickness shall be 330 microns. All paints shall be of approved brand and shade as per owner's requirement.

(iv) Joints to be site welded shall have weldable primer applied within 100 mm of welding zone. Similarly where friction grip fasteners are to be used removable anti corrosive coating shall be provided. On completion of the joint the surfaces shall receive the paint as specified.

(v) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection including top surfaces of floor beams, supporting gratings or chequered plate shall receive one additional coat of finish paint over the above number of coats specified before erection. Portion of steel member embedded/ to be encased in concrete shall not be painted.

(b) Gratings and Step Threads

(i) Surface Preparation

Gratings and step threads shall be cleared by acid pickling as per SSPC-SP-08

(ii) Hot Dip galvanizing

The hot dip galvanizing shall be done as per IS 2629. The average mass of coating shall be 610 gm/m2.

(iii) Post Treatment

Immediately after galvanizing post treatment such as chromating shall be applied to retard white rust attack.

(iv) Touch up mechanical damages

The repair of damages coatings shall be done as per the recommended practice ASTM A780.

6.3 Painting of Indoor components such as valves, pumps, motors, electrical parts, tanks etc.

At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 25 µm may be used.

Prime Coat

Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

At Site

Thorough cleaning to remove oil, grease, dirt and any other contaminants. Derusting of all mechanical damages according to SIS 055900 Grade ST3. Touch up with dry film thickness 50 µm.

Finish Coat

Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 30-40 microns DFT each coat in approved shades.

Remarks

Equipment coated with a standard application system can be accepted if the quality of this application system is corresponding with the quality of the above mentioned system.

6.4 Painting of Outdoor equipment (external surfaces) such as piping, valves, pumps, motors, electrical parts, tanks etc.

Weather exposure, weather resistance, temperature upto 120^0C as per clause 6.1 & 6.3. However

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two (2) layers of Zinc phosphate epoxy, total dry fim thickness 75µm.

Intermediate Coat

One (1) layer 2 pack high build epoxy polyamide MIO, DFT 100µm.

Finish Coat

Application of two (2) finishing coats of chlorinated rubber paint in approved shades at 50 microns DFT each coat in approved shades.

6.5 Special Coating

(a) Parts exposed to temperatures above 120^0C, upto 200^0C, not insulated

(i) At Works

Surface Preparation

Blasting according to SIS 055900 grade Sa 2½ and ISO 8501-1:1958. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry fim thickness 75µm.

(ii) At Site

Pretreatment

Dersuting of all mechanical damages, according to ISO 8501-1:1989, grade St 3 touch up with 1 pack inorganic ethyl zinc silicate, dry film thickness 50µm.

Intermediate Coat

I pack silicon acrylic dry film thickness 35 µm.

Final Coat

1 pack silicon acrylic, dry film thickness as 35µm.
Total system dry film thickness 145µm.
Final coat according to colour code.

(b) **Parts exposed to temperatures above 200^{0}C, upto 400^{0}C, not insulated**

(i) At Works

Surface Preparation

Blasting according to ISO 8501-1:1958 grade Sa-2½. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm.

(ii) At Site

Pretreatment

Derusting of all mechanical damages, according to standard Sa 2½ to ISO 8501-1:1988. Touch up with coating system according to manufacturer's recommendations.

(c) **Insulated parts continuously exposed to condensing water or parts exposed to temperatures**

For parts that are provided with insulation on site.

(i) **Insulated parts exposed to condensing water**

At Works

Surface Preparation

Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Prime Coat

Inorganic ethyl Zinc silicate, total dry film thickness 75µm

(ii) **Insulated parts exposed to temperatures**

Parts exposed to temperatures upto < 400^{0}C

Surface Preparation

Blasting according to Sa 2½ to ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm shall be used.

Parts exposed to temperature above 400^0C at works (Steam pipes, pressure tubes and parts for the HRSG, such as heating surfaces, heaters and superheaters, reheaters etc)

Temporary Primer

Varnish

(d) **Intermittent exposure due to condensing water/ chemicals (Indoors)**

(i) At Works

Surface Preparation

Blasting according to Sa 2½ and ISO 8501-1:1988. Depending on production flow, a weldable, inorganic ethyl zinc silicate shop primer of minimum dry film thickness 15-25 µm may be used.

Prime Coat

Two layers of Zinc phosphate primer, total dry fim thickness 75µm.

(ii) At Site

Pretreatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat

2 pack silicon acrylic, dry film thickness of 50µm.

Total system dry film thickness 205µm.

When exposed o weathering, weather resistance finish coat shall be applied.

(e) **Water Exposure**

(i) At Site/ Works

Pretreatment

Removal of all welding pearls.

Blasting according to Sa 3 to ISO 8501-1:1988

Coat
4 coats 2 pack coal tar epoxy, dry film thickness 125 µm each.

Total system dry film thickness 500µm
Touch up after erection as required.

6.6 Painting of Pipes

6.6.1 Buried Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Coal tar primer compatible with coal tar enamel grade. The number of coats shall be two with a DFT of 35 microns each.

(iii) Coal tar enamel shall be applied. A single spiral inner wrap of glass fibre tissues shall be applied overlapping at least 25 mm ensuring impregnation of glass fibre tissues in the first coat. The second coat of enamel and second outer wrap of glass fibre felt, Type – I to IS: 7193-1974 will be applied in the same way confirming to Table – 10 of IS – 10221 – 1982.

The total thickness of the coating will not be less than 4.0 mm

(iv) Alternatively Wrapping with coal tar based anticorrosion tape conforming to IS 15337: 2003 is also acceptable in lieu of s.no. (iii) above. Wrapping thickness shall be 4.0 mm.

Tests to be carried out after application : Bond/ Adhesion test, Holiday test

6.6.2 Overground Piping

Internal surfaces

(i) Surface cleaning by sand blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

The total dry film thickness of 150 microns.

Note : All steel pipes carrying sea water shall be internally coated with corrocoat/ polyurea coating having thickness 1500 DFT.

External surfaces

(i) Surface cleaning by Sand Blasting.

(ii) Two (2) coats of epoxy primer coats. The minimum DFT of each coat shall be 35 microns.

(iii) Finish coat-Two (2) coats of high build epoxy paint. The minimum DFT of each coat shall be 35 microns.

6.7 Internal Coatings

6.7.1 Tanks (Internal surfaces) as specified in relevant sections of specification

Industrial deionised, demineralised and potable water upto 60^0C pH range 4.5-9.5

Blasting according to Sa 2½ and ISO 8501-1:1988.

Prime Coat

Two layers of Zinc phosphate epoxy primer, total dry fim thickness >75µm.

Pretreatment

Dersuting of all mechanical damages, according to standard Sa3 to ISO 8501-1:1988, touch up with 2 pack high build epoxy with volume solid content of more than 85%, 75µm.

Intermediate Coat

2 pack high build epoxy, dry film thickness 80 µm.

Finish Coat

2 pack silicon acrylic, dry film thickness of 150µm per coat.

In case of service or potable water tanks, the coating material selected shall not taint the water. The paint system shall confirm to regulations issued by Food & drug administration/ National Public Health service/ AWWA/ OSHA and comply with applicable laws, regulations, ordinances etc. of the local authority, state or the nation pertains to work.

QA/ QC Procedure including pinhole inspection, shall be submitted for approval by Owner/ Owner's representative.

6.6.2 Rubber Lining of Pipes, Valves and Tanks for DM Water

Pretreatment

Blasting according to Sa 2½ and ISO 8501-1:1988

Rubber Lining

Hard rubber 5 mm for DM water applications as IS – 4682

6.7 Painting for Electrical items

6.7.1 All the steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt and swarf by pickling, emulsion cleaning etc. The sheet steel shall be phosphate/ oven dried and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing epoxy paint shall be applied. The colour of the finishing coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS-5/ RAL 7032 for all switchboard/ MCC/ Distribution boards, control panels etc.

6.7.2 All electrical equipment shall be given tropical and fungicidal treatment and outdoor equipment shall be provided with rain hood to prevent entry of rain water into the equipment.

6.7.3 Painting of I & C equipment : Epoxy coating required for all I & C equipment.

6.8 SUGGESTED COLOUR CODES FOR PAINTING

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
1.	Structures, platforms, galleries, ladders and handrails	Dark Admirality Grey	632	-	-
2.	Boiler casing, ducting	Nut Brown	413	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
3.	Crane				
3.1	Crane structure	Golden Yellow	356	Black	-
3.2	Trolley & hook	Crimson	540	-	-
4.	Fans, pumps, motors, compressors	Light Grey	631	-	-
5.	Tanks (without insulation and cladding)				
5.1	Outdoor	Aluminium	-	-	-
5.2	Indoor	Light grey	631	-	-
6.	Vessels & all other proprietary equipment (without insulation & cladding)	Light grey	631	-	-
7.	Switchgear	Light grey (Powder coated)		-	-
8.	Control & relay panels	Light grey (Powder coated)	631/70 78 of IS 1650	-	-
9.	Turbines	Light Grey	631	-	-
10.	Generators & Exciter	Light Grey	631	-	-
11.	Transformers	Aluminum	-	-	-
12.	Machinery guards	Signal red	537	-	-
13.	Piping (without insulation and cladding)				
13.1	Water System				
a	Boiler feed	Sea Green	217	-	-

SL. NO.	ITEM/SERVICE	COLOUR	IS-5	COLOUR (BAND)	IS-5
b	Condenstae	Sea Green	217	Light Brown	410
c	DM Water	Sea Green	217	Light Orange	557
d	Soft Water	Sea Green	217	French Blue	166
e	Bearing Cooling Water	Sea Green	217	French Blue	166
f	Potable & filtered Water	Sea Green	217	French Blue	166
g	Service and clarified water	Sea Green	217	French Blue	166
h	Cooling water	Sea Green	217	French Blue	166
I	Sea Water	Sea Green	217	White	-
14.	Ash Transmitting Vessels and pipe lines	Aluminium	-	-	
15.	**Air System**				
15.1	Station air	Sky blue	101	-	-
15.2	Control air	Sky blue	101	White	-
16.	**Oil system**				
16.1	Fuel oil	Light brown	410	French	166
16.2	Light oil (HSD)	Light Brown	410	Brilliant green	221
16.3	Lubricating oil	Light brown	410	Light grey	631
16.4	Transformer oil	Light brown	410	Light orange	557
17.	Gas System				
17.1	Carbon dioxide	Canary yellow	309	Light grey	631
17.2	Hydrogen	Canary yellow	309	Signal red	537
18.	Fire services	Fire red	536	-	-
19.	Effluent pipes	Black	-	-	-
20.	Vacuum pipes	Sky blue	101	Black	-

Notes :

1. This colour code basically refers to IS:2379 for piping with necessary modifications

2. Where band colour is specified, same shall be provided at 30 meter intervals on long uninterrupted lines and also adjacent to valves and junctions.

   Bidder shall furnish his painting specification to suit corrosive atmosphere of coastal area along with the bid. The specification shall in general be in line with the above requirements.

SECTION: I

SUB-SECTION: C-3

TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure–I [Scope of Work (Electrical)].

1.2 Bidder shall furnish all AC as well as DC loads required for the system at different voltage levels (eg. 415V AC, 240 V AC, 220 V DC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.

2.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

2.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated.

2.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

3.0 LIST OF ENCLOSURES

3.1 Electrical scope between BHEL & vendor (Annexure-I).
3.2 Technical specification - Motors
3.3 Datasheets –
3.4 Quality Plan for motors.
3.5 Load data format (Annexure-II).
3.6 Explanatory note for Cable routing & Cable schedule format.

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: VENTILATION / AC
SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT
PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	240 V AC (supply feeder)/415 V AC (3 PHASE 4 WIRE) supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	 BHEL BHEL BHEL	 BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
5	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
6	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and control cables.
7	Conduit and conduit accessories for cabling between	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES: VENTILATION / AC

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	equipment supplied by vendor			rigid conduit as per IS: 9537.
8	Lighting	BHEL	BHEL	
9	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
10	Below grade grounding	BHEL	BHEL	
11	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
12	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract without any commercial implications.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

TECHNICAL SPECIFICATION/DATASHEET

S.No.	Parameters	Requirement
1	Applicable Standards	1) Three phase induction motors : IS:325, IEC:60034, IS: 12615 2) Single phase AC motors : IS:996, IEC:60034 3) Energy Efficient motors : IS 12615, IEC:60034-30 4) Designation of Methods of Cooling of Rotating Electrical Machines : IS 6362. 5) Designation for types of construction and mounting arrangement of rotating electrical machines : IS 2253
2	Rated voltage	415V, 3 Phase
3	Frequency (Hz)	50Hz
4	Permissiblel variations for	
	a) Voltage	+/-10%
	b) Frequency	(+)3 to (-)5%
	c) Combined	10 % (absolute sum)
	System fault level at rated voltage	50KA for 1 sec
	Short time rating for terminal boxes	50KA for 0.25 sec
5	Type of motors	Continous duty (S1) squirrel cage induction motor suitable for direct-on-line starting.
6	Efficiency class	IE3
7	Design margin over continous max. demand of the driven equipment (min)	refer sl. No.16
8	Starting requirement	
	a) Minimum permissible voltage as a percentage of rated voltage, at start to bring the driven equipment upto the driven equipment upto rated speed	85%
	b) Maximum locked rotor current	as per IS 12615
	c) Starting duty	Two hot starts in succession, with motor initially at normal running temperature.
	d) the locked rotor withstand time under hot condition at highest voltage limit	a) atleast 2.5 secs. more than starting time(for motors with starting time upto 20 secs. at minimum permissible voltage during starting) b)atleast 5 secs. more than starting time(for motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting) c) more than starting time by at least 10% of the starting time(For motors with starting time more than 45 secs.at minimum permissible voltage during starting) Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
	e)The ratio of locked rotor KVA at rated voltage to rated KW	(a) Below 110KW : 10.0 (b) From 110 KW & upto 200 KW : 9.0
9	Torque (percent of full load torque)	1] Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque. 2]Pull out torque at rated voltage shall not be less than 205% of full load torque.
10	Noise level (max.)	as per IS:12065
11	Vibration shall be limited within the limits	as per IS:12075
12	Construction Features	
(i)	Enclosure Details	
	a) Degree of protection	i) Indoor motors - IP 54 ii) Outdoor motors - IP 55
	b) Method of ventilation	Totally enclosed fan cooled (TEFC) or totally enclosed tube or ventilated (TETV) or Closed air circuit air cooled (CACA) type.
(ii)	Insulation	Class 'F' with temperature rise limited to class 'B'
(iii)	Bearings	Grease lubricated ball or roller bearings for Horizontal motors Grease lubricated ball or roller bearings or combined trust and guide beaing for Vertical motors.
13	Main terminal box	
	Type	-Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation. -Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame. - The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
	DOP	same as motor
	Position when veiwed from the non driving end	- Left hand side
	Rotation	90 Deg.
	Space heater	Motors rated 30KW and above shall have sapce heater. Separate terminal box for space heaters & RTDs shall be provided.

	Cable glands and lugs	-Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used. Gland plates of thickness 3 mm (hot/cold rolled sheet steel) or 4 mm (non magnetic material for single core cables) shall be provided in case of cable boxes.
	Minimum clearances to be provided between phase to phase and phase to earth	25MM
14	Earthing points 2 nos. suitable for conenction	Motor body shall be grounded at two earthing points on opposite sides with two separate and distinct grounding pads complete with tapped holes, GI bolts and washers.
15	Paint shade	Corrosion proof paints of colour shade Siemens grey (RAL 7032)
16	Testing	1. All type & Routine tests shall be as per IS 12615. 2. The Contractor shall submit the type tests reports for the tests conducted on the equipment similar to those to be supplied under this contract and the test(s) should have been conducted at an independent laboratory not earlier than five (5) years prior to supply under this contract. 3. In case the contractor is not able to submit valid report of the type test(s) or in case type test report(s) are not found to be meeting the specification requirements, or not including all specified tests the contractor shall conduct all such tests under this contract. The cost of such test shall be deemed to be included in the price. The owner shall have right to witness the type tests. 4. All routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
17	additional requirement	1. The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher, considering highest system frequency. 2. Canopy shall be provided for outdoor motors. 3. Temperature Rise: 1. Air cooled motors: 70°C by resistance method. 4. Motors shall be capable of restarting under full load after a momentary loss of voltage with the possibility of 150 % nominal voltage during fast bus transfer. 5. Winding/ Insulation type: Non-hygroscopic, oil resistant, flame resistant. 6. All motors below 15 kW shall be provided with sealed ZZ bearings.
DATA TO BE FURNISHED BY SUCCESSFUL BIDDER AFTER ORDERING		
1. GENERAL		
i)	Manufacturer & Country of origin.	
ii)	Equipment driven by motor)	
iii)	Motor type	
iv)	Country of origin	
v)	Quantity	
2. DESIGN AND PERFORMANCE DATA		
i)	Frame size	
ii)	Type of duty	
iii)	Type of enclosure and method of cooling	
vi)	Type of mounting	
vii)	Direction of rotation as viewed from DE END	
viii)	Standard continuous rating at 40 deg.C. ambient temp. as per Indian Standard (KW)	
ix)	(A) Derated rating for specified normal condition i.e. 50 deg. C ambient temperature (KW)	
	(B) Rating as specified in load list	
xi)	Rated speed at rated voltage and frequency	
xii)	At rated Voltage and frequency	
	a) Full load current (Amps)	
	b) No load current (Amps)	
xiii)	Power Factor at	
	a) 100% load	
	b) At duty point	
	c) 75% load	
	d) 50% load	
	e) NO load	
	f) Starting.	
xiv)	Efficiency at rated voltage and frequrecy	
	a) 100% load	
	b) At duty point	
	c) 75% load	
	d) 50% load	
xv)	Starting current (amps) at	
	a. 100 % voltage	
	b. Minimum starting voltage	
xvi)	Starting time with minimum permissible voltage	
	a. Without driven equipment coupled	
	b. With driven equipment coupled	

xvii)	Safe stall time with 110% of rated voltage	
	a. From hot condition	
	b. From cold condition	
xviii)	**Torques :**	
	a. Starting torque at min. permissible voltage(kg-mtr.)	
	b. Pull up torque at rated voltage.	
	c. Pull out torque	
	d. Min accelerating torque (kg.m) available	
	e. Rated torque (kg.m)	
xix)	Stator winding resistance per phase (ohms at 20 Deg.C.)	
xx)	GD^2 value of motors	
xxi)	Locked rotor KVA input (at rated voltage)	
xxii)	Locked rotor KVA/KW.	
xxiii)	**Bearings**	
	a. Type	
	b. Manufacturer	
	c. Self Lubricated or forced Lubricated	
	d. Recommended Lubricants	
	e. Guaranteed Life in Hours	
	f. Whether Dial Type thermometer provided	
	g. Oil pressure Gauge/switch	
	i. Range	
	ii. Contact Nos. & ratings	
	iii. Accuracy	
xxiv)	**Vibration**	
	a) Velocity (mm/s)	
	b) Displacement (microns)	
xxv)	Noise level (DB)	
3. CONSTRUCTIONAL FEATURES		
i	Stator winding insulation	
	a. Class & Type	
	b. Tropicalised (Yes/No)	
	c. Temperature rise over specified max.	
	i. Cold water temperature of 38 DEG. C.	
	ii. Ambient Air 50 DEG. C.	
	d. Method of temperature measurement	
	e. Stator winding connection	
	f. Number of terminals brought out	
ii	Type of terminal box for	
	a. stator leads	
	b. space heater	
	c. Temperature detectors	
	d. Instrument switch etc.	
iii)	For main terminal box	
	a. Location	
	b. Entry of cables	
	c. Recommended cable size	
	d. Fault level (MVA)	
iv)	Temperature detector for stator winding	
	a Type	
	b. Nos. provided	
	c . Location	
	d. Make	
	e. Resistance value at 0 deg. C. (ohms)	
vi)	Paint shade	
vii).	Weight of(approx)	
	a. Motor stator (KG)	
	b. Motor Rotor (KG)	
	c. Total weight (KG)	

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	*	AGENCY			REMARKS
1	2	3	4	5	6		7	8	9	D	**			
					M	C/ N					M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V *	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:	KUNAL GANDHI	KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:
1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, INDENTIFIED WITH "TICK"(√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,
** **M**: SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, B: MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C**: CUSTOMER,
P: PERFORM, **W**: WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI**: MINOR**, CR:** CRITICAL
D: DOCUMENTATION

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:	HEMA KUSHWAHA	HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:	PRAVEEN DUTTA	PRAVEEN DUTTA	Reviewed by:	RITESH KUMAR JAISWAL	RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (dc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

BHEL	LOAD DATA (ELECTRICAL)	JOB NO.	412	ORIGINATING AGENCY	PEM (ELECTRICAL)
		PROJECT TITLE	2X660MW ENNORE TPP	NAME	DATA FILLED UP ON
		SYSTEM / S	AIR CONDITIONING SYSTEM	SIGN.	DATA ENTERED ON
		DEPTT. / SECTION		SHEET 1 OF 1 REV. 00	DE'S SIGN. & DATE

CABLE SCHEDULE FORMAT **ANNEXURE III**

UNITCABLENO	FROM	TO	PURPOSE	CABLE SCOPE (BHEL PEM/ VENDOR)	REMARKS	CABLESIZE	PATHCABLENO	TENTATIVE CABLE LENGTH

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:
(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED
W = PAIRED INDIVIDUAL SCREENED
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
    a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
    b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
    e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
    f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
    g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
|	|	|	|
Cable Voltage Code (see B below)	No. of cores (e.g. 01,03,3H, 07)	Cable code (See C below)	Cable size (e.g. 035,185,2.5, 0.5)

(A) SYSTEM VOLTAGE CODES:
(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:
A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

B = 6.6KV (Power cables)
C = 3.3KV (Power cables)
D = 1.1KV (LV & DC system power & control cables)
E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
T = TOUGH RUBBER SHEATH
U = OVERALL SCREENED
V = PAIRED OVERALL SCREENED (G-Type)
W = PAIRED INDIVIDUAL SCREENED (F-type)
Y = COMPENSATING CABLES
I = PRE-FABRICATED CABLES
Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.

SECTION: I

SUB-SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

Table of Contents

SPECIFIC
TECHNICAL REQUIREMENT

Specific Technical Requirements (C&I)

1) The control of Air Conditioning System Plant shall be through DDCMIS (BHEL's scope) based control system located in respective AC Plant Control Rooms. DDCMIS panels, Back up control desk, UPS, OWS, OEWS, and printers shall be provided by BHEL.

2) Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System and the closure of relevant fire dampers in Air Conditioning and Ventilation System.

3) The solenoid valves shall have limit switches for open/close feedback.

4) All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope. RTD's shall be of duplex type. Temperature transmitters are envisaged for RTD for monitoring services/application only.

5) Local control panels, wherever applicable, shall be provided by the vendor.

6) Provision for redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Air conditioning DDCMIS and chiller's Microprocessor based control panel.

7) Bidder to delegate /depute their persons/experts (15 working days for minimum 3 tours) as per owner/consultants' requirement without any additional cost at site during commissioning.

8) 8 Nos. temperature elements/sensors in AC control room shall be provided for monitoring the room temperature. Temperature & humidity monitoring system shall be in bidder's scope.

9) All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval.

10) Bidder shall provide erection hardware as per installation drawings.

11) 230 V AC UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply & all necessary hardware for the same shall be in bidder scope. Further, Bidder to furnish UPS load data during detailed engineering in BHEL format.

12) Redundancy of instruments to be provided by bidder shall be as follows:

(i) Triple redundancy for all analog and binary inputs required for protection of system/drives.

(ii) For all other control functions dual redundancy of the sensors shall be provided by the bidder.

13) The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements as per interpretation of BHEL among them are to be complied with.

14) The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished.

15) All electrical actuators shall be of integral starter type.

16) For plug in type instruments, The plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

17) Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

18) All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved.

19) The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified and an anti-corrosive paint shall be applied to the field mounted enclosures / instruments.

20) All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments. All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

22) Temp. Transmitters are envisaged with RTD for monitoring purpose only.

23) The operation of the pumps shall be interlocked with the low level of water in the sump. High level of the sump shall be annunciated. The standby pump shall be started automatically when the working pump is tripped.

24) Air washer units shall be started/stopped by initiation from the local panel and the starting/stopping of fans and pumps shall be automatic upon such initiation. A selection switch enabling the running of AWU fan or pump alone shall be provided. Both supply and exhaust fans shall be operated locally.

SPECIFICATION FOR MEASURING INSTRUMENTS

TEMPERATURE SWITCHES (TS)	
Type/Construction	
-Switch	Industrial type inert gas filled with capillary and separable thermowell and contacts directly connected to Bourdon element/vapor pressure sensing, gas filled bellows type preferred.
-Thermowell	Bar stock
Material	
-Bulb	316 SS
-Capillary -Bourdon	Armored Stainless Steel 316 SS
-Bourdon Movement	SS 316
-Casing	Die-cast aluminum with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
Contacts	
-Number	DPDT/2 SPDT
-Type	Auto reset with internal Adjustable snap action micro switch
-Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
Setting and Differential	Adjustable
Accuracy	+/- One (1) percent of setting and differential
Repeatability	One half(1/2) percent of setting
Connection Pipe	M33 x 2
Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
Thermowell	To suit Temp. switch with same design criteria as specified for RTDs.
Electrical	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
Other Particulars	
-Capillary length	As per requirement (min 10 meters)
-Immersion Length	Within + ten (10) mm of center line
	of pipe with adjustable nuts.
-Extension neck length	Minimum 50 mm above insulation of
	pipe /As per approved hookup
	drawings.
-Packing glands	Yes
IBR Certification	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations.
N.B	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.
TEMPERATURE GAUGES (TG)	
Applicable standard	IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification
Type/Construction	
-Thermometer	Industrial type, Gas in Filled type with separable thermowell
-Thermowell	Bar stock
Material	
-Bulb	316 SS
-Capillary	Armoured SS (Applicable for capillary Type)
-Casing	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
Dial Size	150mm with shatter proof glass
Scale Details	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges .
Accuracy	+/- One (1) percent or better
Response time	Maximum 15 seconds without thermowell and 30 seconds with thermowell
Connection	
-Pipe	M33 x 2
-Thermowell	To suit instrument with same design criteria specified for RTDs.
-Process Connection	(i) M 33 x 2
	(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
-Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends.
Other Particulars	
-Capillary length	5 Meters/10 Meters as required
-Immersion Length	Within + ten (10) mm of center line of pipe with adjustable nuts.
-Extension neck length	Minimum 50 mm above insulation of pipe /As per approved hookup drawings.
-Stop at Maximum value	For all gauges of scale
-Pointer	Externally adjustable
-Over range protection	150 percent (%) of full scale
Enclosure Class	IP-65 or better (Explosion/Flame proof forNEC Class-1, Division 1 area)
IBR Certification	For high pressure service, Steam

TEMERATURE TRANSMITTERS	
Type	SMART type configurable from control room through HART protocol (HMS System)
Display type	Indicating type (5 digit LCD Display),
Accuracy	+0.10%,
Ambient temperature error	0.1% per 10°C change
Output	4-20 mA DC (2 wire system) HART compatible
Protection class	NEMA 4/IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flame proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
Material of accessories	SS316.
Stability	+ 0.1 % or + 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
Operating Voltage	16 – 48 V DC
Calibration	as per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD
Ref. Junction compensation	To be provided
Span/zero adjustment	Locally adjustable, Non interacting
Auto calibration	To be provided
Burn out protection upscale	To be provided
Input -output isolation	To be provided
Circuit ungrounded	To be provided
Input signals	0-5V, Universal dual inputs of all types of thermocouples & RTD
Note:	
1. Temp. Transmitter shall be extremely stable against Ambient temp variation, The accuracy figure shall be inclusive of effect due to ambient temperature variation.	
RESISTANCE TEMPERATURE SENSORS WITH THERMOWELLS	
RESISTANCE TEMPERATURE SENSORS	
Applicable Standard	ASME PTC 19.3 -Latest Revision
	DIN EN 60751:1996, BS EN/IEC60751: 2008
Element	Platinum, R0=100 ohm 4-wire Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide
Sheath O D	8 MM
-Gauge	18 AWG
Terminals	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
Calibration	As per DIN Standard – 43760, Class A
Head	Hex Head, Die Cast Aluminum (Screwed) with galvanized SS chain
Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermowell
Accuracy	+ 0.35 degree C or Class-A whichever is better.
Electrical connection	Gold plated Plug in type. Double entry - one unused entry with blind plug
Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
THERMOWELL	
Applicable Standard	ASME PTC 19.3 TW -2010 , Bidder shall provide calculation for thermowell as per ASME – PTC-19.3 2010. "All Thermowells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermowells".
-Construction	Tapered drilled from Bar stock (Straight for Air & Gas systems)
-Material	-316 SS/F11/F22/F91 -water and steam Services depending upon process parameters.
-Process Connection	(i) M 33 x 2
	(ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
-Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends.
Immersion length	Within + 10 mm of center line of pipe and as per ASME – PTC-19.3 -2010
Extension neck length	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
Note	The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.

LEVEL SWITCHES (LS)	
Type/Construction	External float cage type with magnetic switch actuator for tanks and vessels.
Materials	
-Body	Cast Carbon Steel/Die cast Aluminum suitable for specified pressure and temperature ratings. For corrosive liquids suitable anti-corrosive coat/lining shall be provided.
-Float/Displacer	316 SS
-Wire rope	316 SS
Contacts	
-Number	DPDT/2 SPDT
-Type	Snap action micro switch Auto reset with internal Adjustable
-Rating	5 Amp 240V AC 0.2 Amp 220V DC
Connection -Process	One (1) inch SCRD NPT Female Or One (1) inch ANSI Flanged , Four(4) inch ANSI Flange for sump services.
Electrical	Suitable for Plug in type connection
Differential	+ 12 mm minimum (Adjustable)
Temperature/pressure rating	As per service conditions
Accessories	Counter flanges, still pipe of requisite length with anticorrosive coating for sump services.
LEVEL INDICATORS (Gauge Glass) (LI)	
Type/Construction	a) Reflex
	b) Tubular (For tanks open to atmosphere only)
Material	
- Glass	Tempered borosilicate resistant to thermal shock
- Case	Carbon steel
- Integral cocks and	i) Forged carbon steel with drain valves stainless steel internals
	ii) Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service)
- Fittings	i) Forged carbon steel
	ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service)
	iii) 304 Stainless Steel for non-corrosive liquids
-Packing	Teflon
Dial size/scale	150 mm /1.5 Meters maximum length with
Scale details	Aluminum/SS316 scale Graduated in mmwc
Connection	25 Nb/40 Nb ANSI Flanged
Accessories	a) Integral cocks b) Drain valves c) Bolts, nuts and gaskets d) Illuminating lamps as required e) Periscope as required
Tests	Tested at two hundred (200) percent of the maximum process pressure
Other details	For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.
Humidity & Temperature Sensor with LCD display for AC Plant	
Humidity Sensor	
Measurement range	0-100%r.h.
Range of use	0-100%r.h.
Measurement accuracy at 23º C 0-100% r.h.	+2%
Temperature dependency	<0.05% r.h./ º C
Output signal, linear (terminal l1)	DC4-20mA = 0-100%r.h.
Temperature Sensor	
Range of use	0-50º C & -35 to 35º C
Sensing element	Pt1000 class A
Measurement accuracy at 15-35º C	+0.5K
Output signal, linear (terminal l2)	DC4-20mA = 0-50º C & -35 to 35º C
General Sensor Data	
Power supply	
Operating voltage	AC 24V +20%
Degree of Protection & Safety Class	
Degree of protection of housing with enclosed cable gland	IP 65 to IEC 529
Safety class	III to EN 60 730
Environmental Condition	
Temperature (housing with electronics)	-40 to 70º C
Humidity	5 to 95% r.h. (non condensing)
Location	In each AHU room and Control room

PRESSURE & DIFFERENTIAL PRESSURE GAUGES (PG & DPG)	
Applicable standard	IS:3602-1966, IS/3624, ASME B 40.1
Type/Construction	
-760 mm to 1.0Kg/cm2	Bellows/Diaphragm
-Above1.0Kg/cm2	Bourdon Tube
-Suction side of pumps	Compound gauge
Materials	
-Bourdon tube	316 SS
-Bellows	316 SS
-Movement	316 SS
-Case	SS 316/ Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
-Protective Diaphragm	Teflon
Dial size	150mm with shatter proof glass
Scale Details	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
Accuracy	+ One (1) percent or better
Connection - Process	1/2 inch NPT Male Bottom
Mounting	Local , 1/2 inch NPT Male (Back entry) mounted on local gauge board.
Enclosure Class	IP-65 or better (Explosion/Flame proof forNEC Class-1, Division 1 area)
Accessories	
-3 way needle valve/manifolds	For all gauges
-Self cleaning type Pulsation dampener/snubber (S316)	Pump and compressor discharge lines
-Syphon	For all steam lines
-Protective separating	For fuel oil and corrosive liquid lines
Other particulars	
-External Zero adjustment	For all gauges
-Safety device	For all gauges
Ranges 5 to 20 Kg/cm2	Rubber blow out disc with open front construction
Ranges above 20 Kg/cm2	Neoprene safety diaphragm at the back with solid front construction
-Over range protection	One Fifty (150) percent of full scale
Other Requirments	Movement mechanism shall be glycerin filled for oil services & vibration prone area.
	For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armored capillary of 10 M for Fuel oil & Corrosive liquid service.
PRESSURE SWITCHES (PS) & DIFFERENTIAL PRESSURE SWITCHES (DPS)	
Applicable Standards	IS3624 -1966/ISA-RP-8.1 except as modified in spec
Type/Construction	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable
Materials	
-Bellows	316 SS
-Bourdon tube	316 SS
-Movement	316 SS
-Enclousre	Die-cast aluminum with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
-Protective Diaphragm	Teflon
Contact	
-Number	DPDT /2 SPDT
-Type	Auto reset with internal Adjustable
	snap action micro switch
-Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
Connection	
-Process	Half (1/2) inch NPT Male
-Electrical	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
Accuracy	+ One (1) percent or better
Repeatability	+ 0.5(half) percent or better
Setting & Differential	Adjustable
Over range protection	One Fifty (150) percent of full scale
Enclosure Class	IP-65 or better (Explosion/Flame proof forNEC Class-1, Division 1 area)
Accessories	
-3 / 5 valve manifold	As applicable for all switches
-Self cleaning type pulsation dampners/Snubber (Material SS316)	Pump and compressor discharge lines
-Syphon	For all steam lines
-Protective separating diaphragm	For fuel oil & corrosive liquid lines
Mounting	Local (in LIE/LIR for BTG package)

Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)	
Type/Construction	Sealed capacitance/ Inductance/ Silicon resonance type , SMART type
Body Material	Die cast Aluminum with epoxy coating for air & flue gas , SS316 for other services
Diaphragm Material	316 SS
Measurement element Material	Teflon seal
Valves Material	Carbon steel for non-corrosive Applications , SS316 for corrosive applications
Output signal	4 to 20 m Amp. DC (Two wires) HART Compatible
Local Indicator	LCD indicator (5 digit) with scale of Engg. unit
Overall Accuracy	+ 0.04% or better of Span for BTG package
	+ 0.065% or better of Span for BOP packages
	+ 0.2% or better of span for remote seal type transmitter
Turn down ratio	100:1 in general
Stability	+ 0.15% of URL for 5 years.
Response time	150 msec.
Power supply	24V DC nominal
Drive capability	600 Ohms nominal
Enclosure Class	IP-65 (Explosion proof for NECClass-1, Division 1 area)
Span and Zero	Locally adjustable, non-interacting
Zero suppression / elevation	At least 100% of Span
Process Connection	1. Half (1/2) inch NPT (F) , Quarter (1/4) inch NPT with/without oval flanges
Electrical Connection	Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.
Over Range Protection	Required when necessary
Manifold	Non integral and standalone type, should not be mounted on Transmitter
Accessories	
For Absolute Pressure Transmitters	Two (2) valve SS316 manifold
For Gauge & Vacuum pressure transmitter	Three (3) valve SS316 manifold
For DP, level & flow transmitter	Five (5) valve SS316 manifold
For oil and corrosive liquids	Separator diaphragm seals
For all transmitters	Mounting bracket
Notes:	
1. Snubbers/Pulsation dampners shall be used where the process mediais unstable for measurement such as the discharge of a pump.	
2. The coil syphons & condensate pots shall be used for steam services.	
3. Transmitters shall be provided with suitable drain & vent points.	
FLOW GAUGES (FG)	
Type/Construction	a) On-line type Rotameter for 50 Nb and below lines
	b) Bypass type Rotameter for above 50 Nb lines.
Material	
-For On-line type	
Metering Tube	Borosilicate glass
Float	316 SS
Packing	Teflon
End fittings	304 SS
-For Bypass type	
Metering Tube	Borosilicate glass
Float	316 SS
Packing	Teflon
End Fittings	304 SS
Orifice Plate	316 SS
Carrier ring	304 SS
Flanges & Mating flanges	Same as pipe material, 200 lbs ANSI-RF
Impulse pipe	Same as pipe material
Fittings	2000 ANSI, SW ends to match with pipe material
Dial Size/Scale length	250 mm
Scale Details	Direct reading type engraved on detachable Aluminum scale
Accuracy	+/- Two (2) percent
Reproducibility	Half (1/2) percent
Rangeability	1:10
Connection	SCRD NPT
Accessories	a) Isolating valves (for Bypass type only)
	b) Bolts, Nuts and Gaskets as required
Tests	Shall be tested at two hundred (200) percent of the maximum process pressure

Ultrasonic Level Transmitter	
Principle of Operation	Detection of reflected ultrasonic pulse
Measuring Ranges	Up to 30 meters (typical)
Signal Processing	Microprocessor Controlled Signal Processing
Operating Freq.	10 KHz to 50 KHz (typical)
Display	Head mounted alpha-numeric back lit LCD/LED
Calibration & Configuration	Accessible from front of panel & HART calibrator.
Diagnosis	On-line
Status	For power, Hi / Lo / V. Hi / V. Lo-level indication, fault etc.
Construction	Plug-on board
Power supply	240 V AC 50 Hz / 24V DC
Signal Output	4-20 mA DC with HART (isolated) -600 Ohm load.
Hysteresis	Fully adjustable preferred
Output contacts	2SPDT Potential free changeover contacts @ 8A 230V AC.
Accuracy & Repeatability	+ 0.25% of span or better
Resolution	+ 0.1% of span
Temperature Compensation	To be provided with Transducer.
Operating temp.	Transmitter-50 deg C and Sensor – 80 deg C
MOC Sensor	Body- PVDF and Face – Polyurethene
Humidity	1% to 95% non condensing.
Enclosure	IP-67 Epoxy painted die cast Aluminum or SS316L housing.
Cable Connection	3/4" ET
Mounting	2” – 4” NPT or flanged
Accessories	Cable gland, prefab cable,mounting accessories like EPDM seal, SS316 flanged etc. Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering
Junction Boxes	
Type	Flame proof/weather proof
Enclosure	IP-65/Explosion/Flame Proof as per area classification.
Material	FRP with protective Coating
Cable entry	Bottom or Side
Cable glands	Double compression type – Nickel plated brass with PVC hoods.
Mounting	Indoor/Outdoor
No. of terminals	As required with standardization with 20% spare of each size & type.
Terminals	Phoenix/Wago (screw less cage clamp type spring loaded)
Grounding	Two terminals for body and shield ground
Door	Hinged, lockable type.
1. Suitable mounting clamps and other accessories shall be in scope of bidder.	
2. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted.	
3. M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.)	
4. Gasket (Normal)-Neoprene thickness 6.0 mm	

Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy +0.2% with zero stability feature, suitable for process medium with <= 5 micron Siemens conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totaliser, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

Instrument Air System

The instrument Air Supply System for various pneumatic Control & Instrumentation devices like pneumatic actuators, power cylinders, I/P converters, pneumatically operated valves etc. shall be complete in all respect with necessary Air Filter Regulators, valves, piping/tubing etc.. Each pneumatic instrument shall have an individual air shut off valve. The pressure-regulating valve shall be equipped with an internal filter, a 50 mm pressure gauge and a built in filter-housing blow down valve. Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.
For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation values are laid to the application. These bulk header are to be provided with **mechanical / electronic based automatic Drains.** Individual moisture separator for O2 analyzer or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

Air Filter Regulator (AFR)

Constant bleed type AFR with an accuracy of + 1.0 % inlet pressure range of 5-8 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves for phosphor bronze filter element; Filtering particles above five microns. Weather and water proof enclosure. Material of accessories will be SS316.

Air filter regulators shall be provided in the :
(a) Air supply line to valve positioners / power cylinders
(b) Air supply line to electric to pneumatic converters.
(c) Air supply line to pneumatic interlocked block valves.
(d) For each instrument rack, field instruments enclosure for purging.

Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:
(a) Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

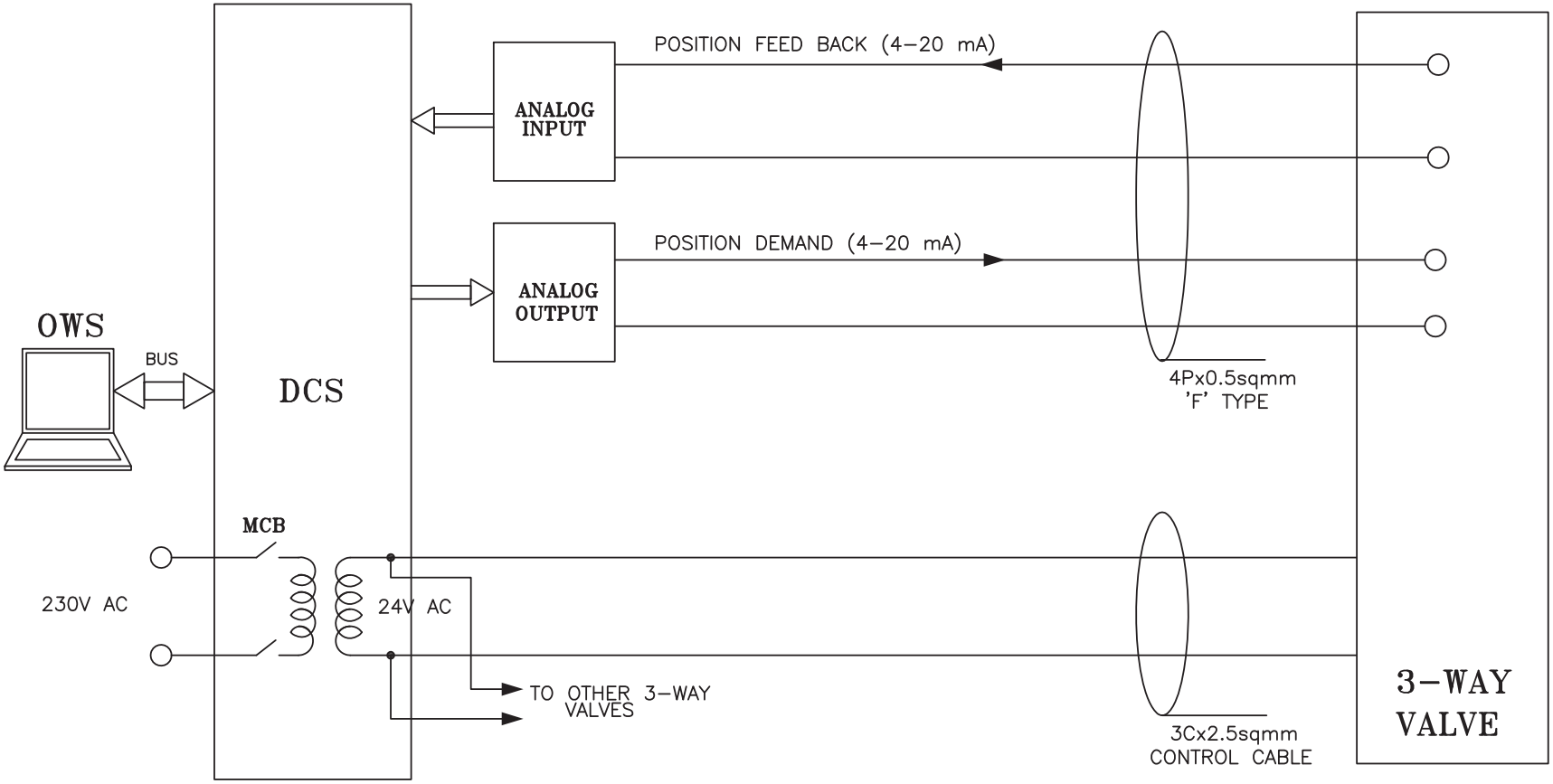
(b) Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g, Pneumatic operated spray water block valve.
(c) Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g, Pneumatically operated on-off type dampers.
(d) For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., **double coil solenoid valve** (latch coil & re-latch coil) shall be adopted. **Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.**
(e) Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4)/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) As applicable). Body material of solenoid valve shall be Die Cast Aluminum or SS316.
(f) All solenoid shall be with varister, LED indication, surge suppress diode and circuits.

Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Free wheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from –20 deg. C to 60 deg. C. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94”, IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

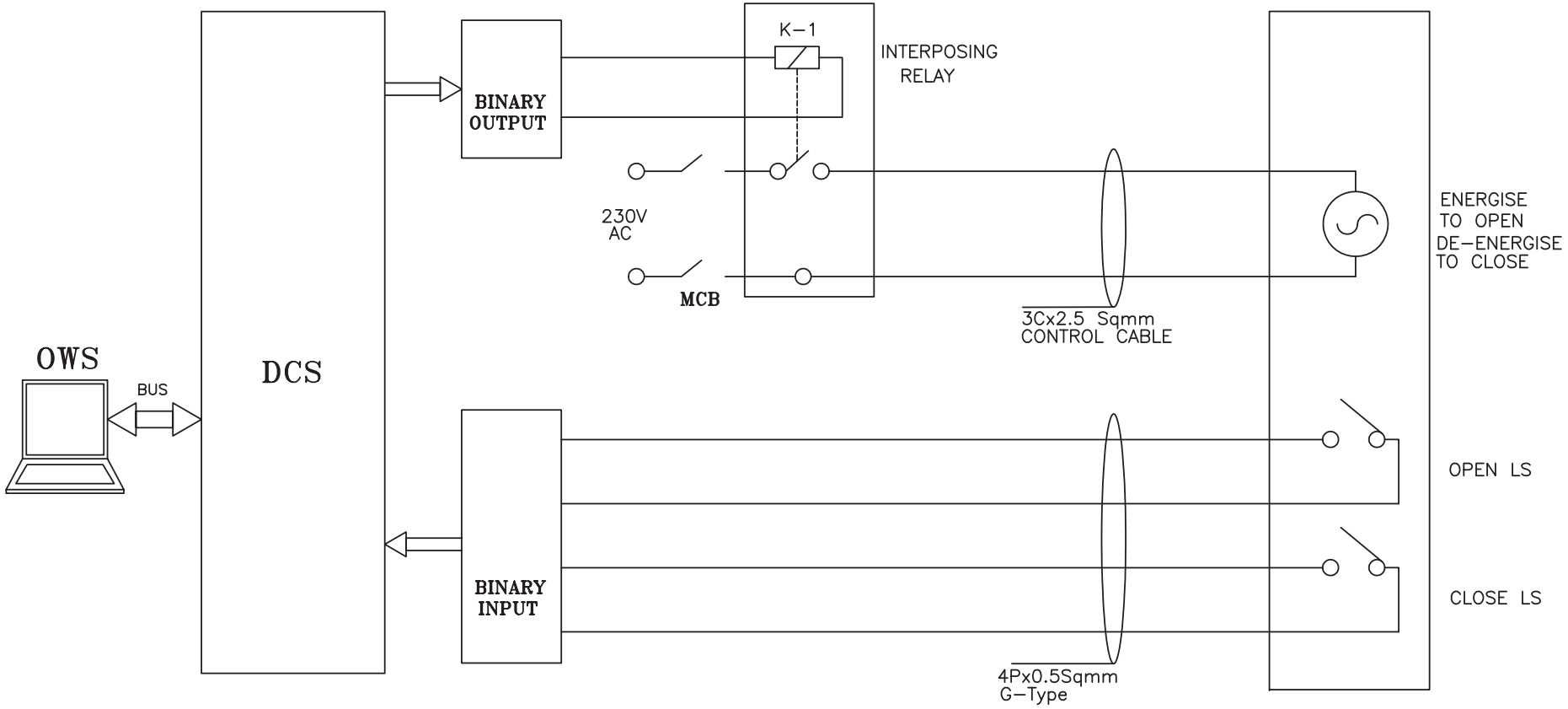
DRIVE CONTROL PHILOSOPHY

DCS INTERFACE FOR 3–WAY MIXING VALVE (MOD–AC)



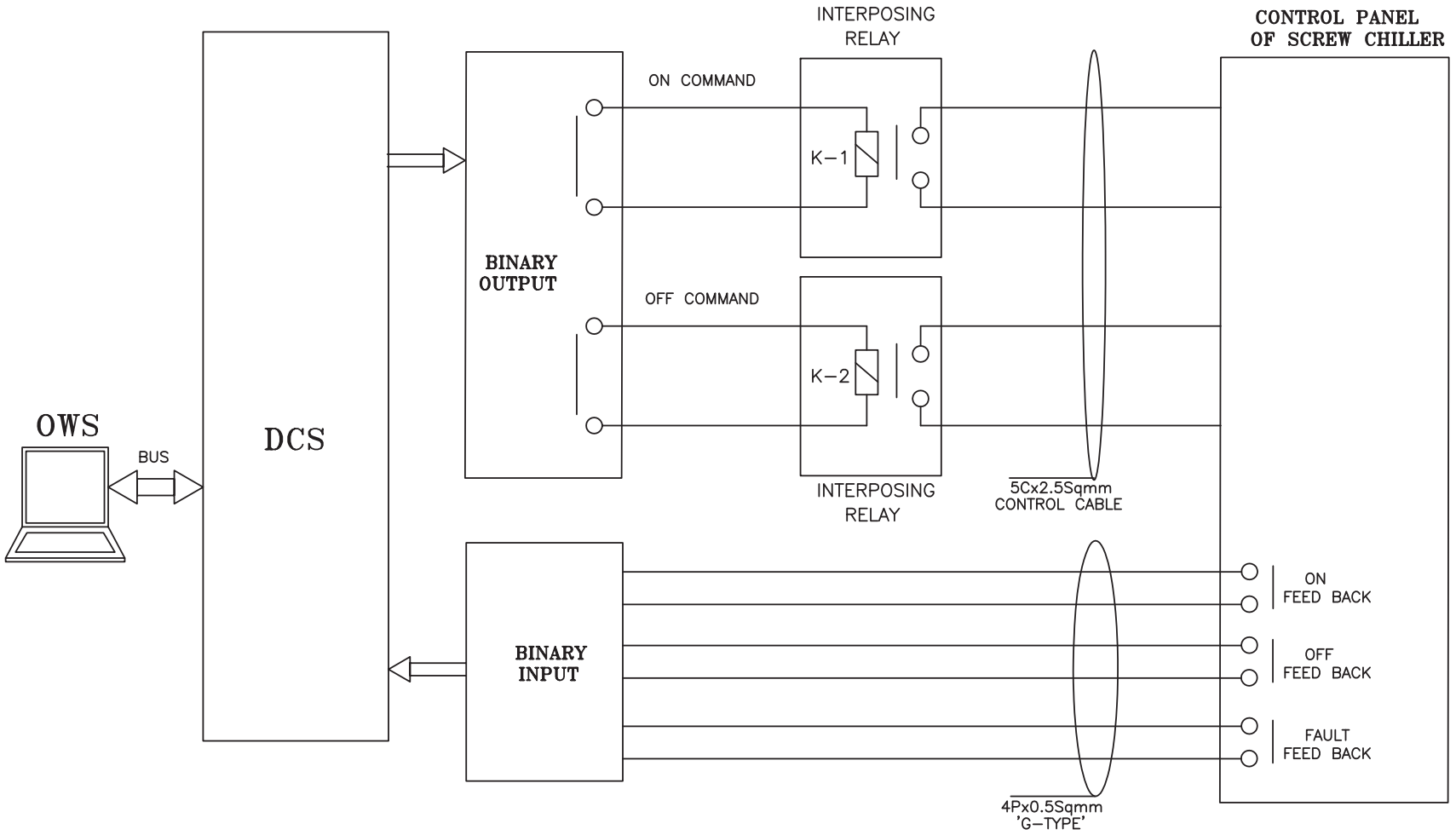
BHEL		DRG.NO.	
		DATE	14.12.2016
	TITLE: REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE	REV.NO.	00
		SHT 2	OF 6

DCS INTERFACE FOR MOTORIZED OPERATED FIRE DAMPER (BID–FD)



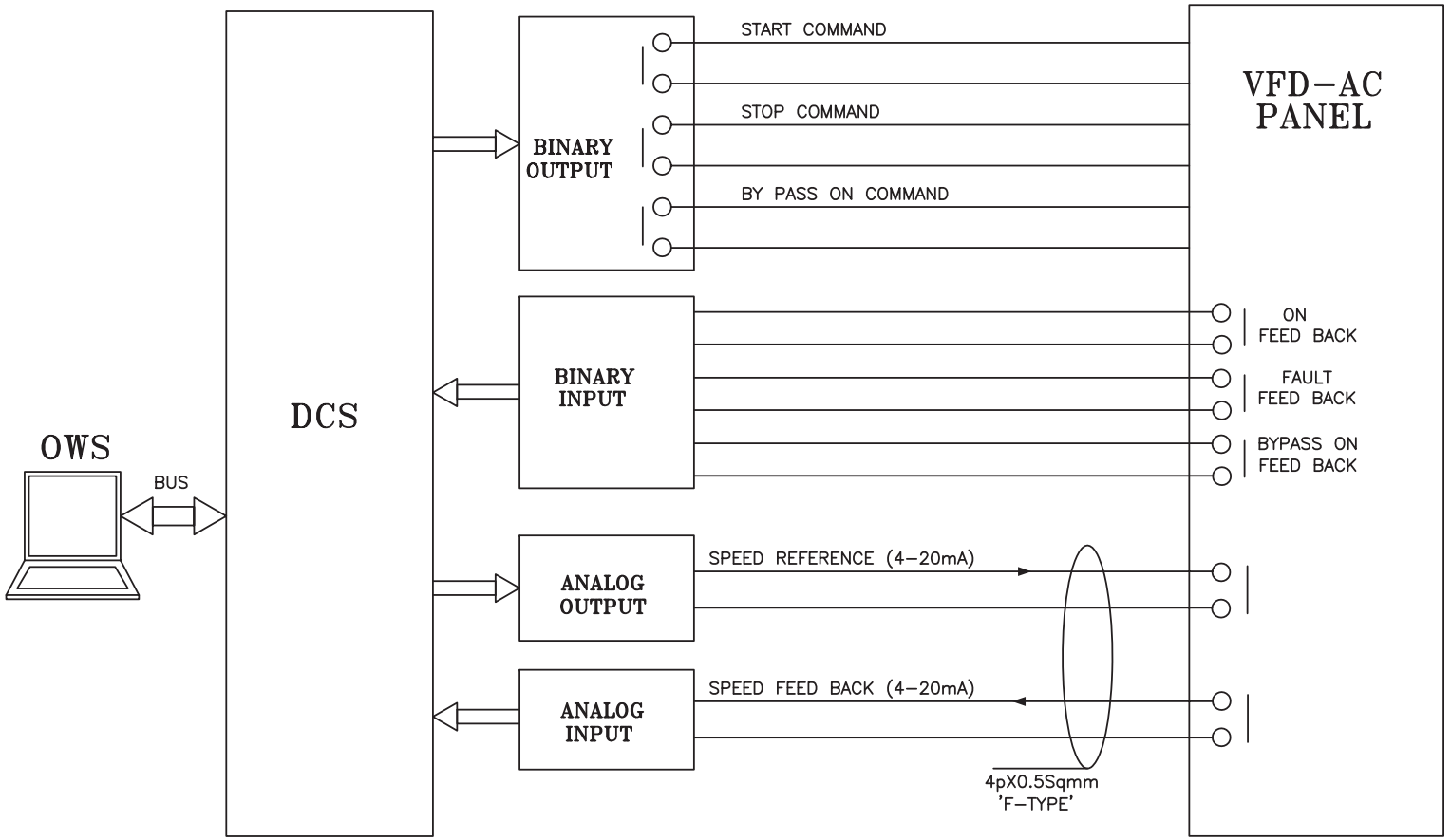
BHEL		DRG.NO.	
		DATE	14.12.2016
	TITLE: REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE	REV.NO.	00
		SHT 3	OF 6

HOOK–UP DIAGRAM FOR SCREW CHILLER MACHINE



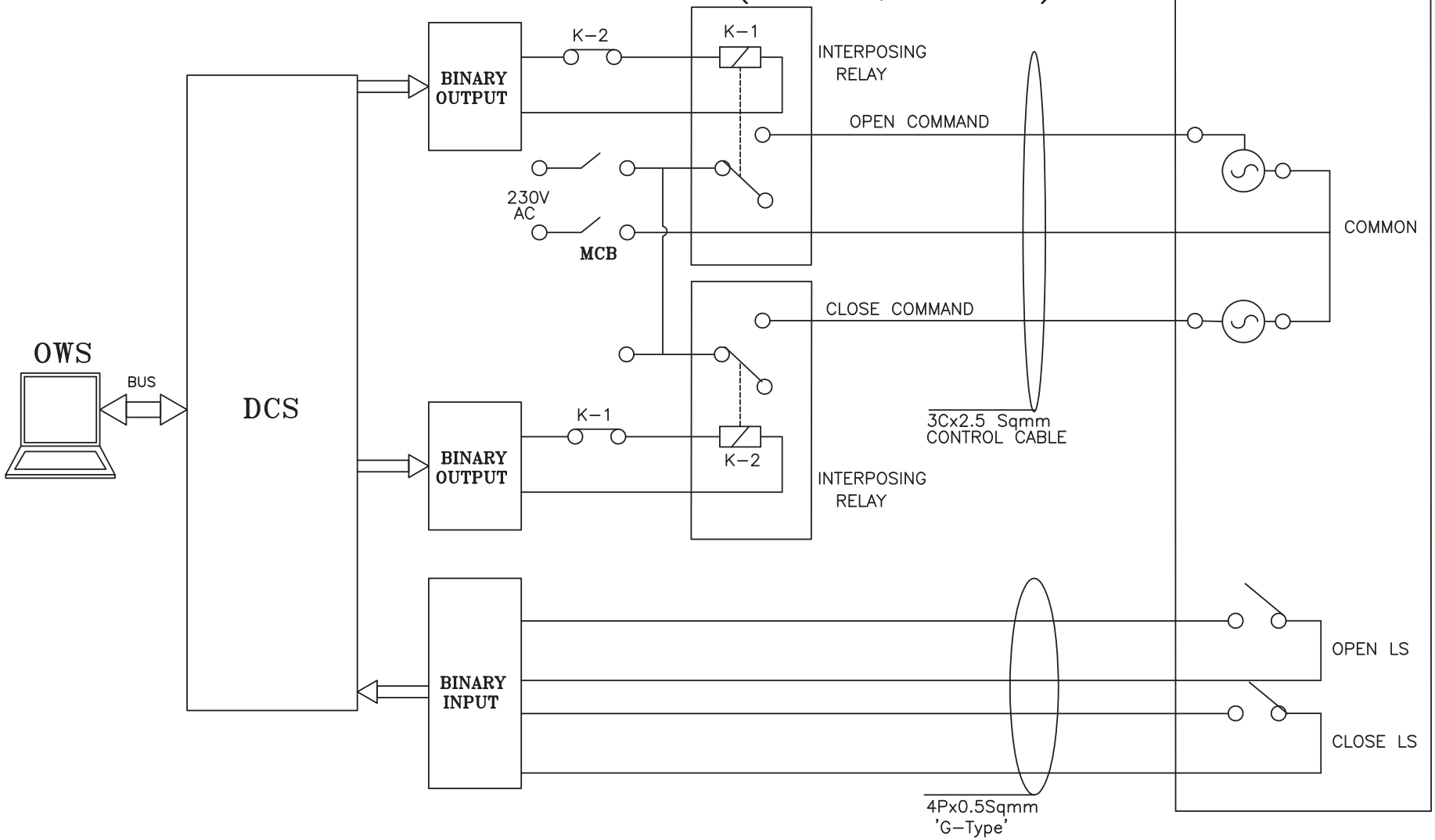
BHEL		DRG.NO.	
		DATE	14.12.2016
	TITLE: REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE	REV.NO.	00
		SHT 4	OF 6

DCS INTERFACE FOR CT FANs/AHUs VFD(VFD–AC)



BHEL		DRG.NO.	
		DATE	14.12.2016
	TITLE: REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE	REV.NO.	00
		SHT 5 OF 6	

DCS INTERFACE FOR MOTORIZED OPERATED VALVES (BID-AC,BID-VCD)



BHEL		DRG.NO.	
		DATE	14.12.2016
	TITLE: REFERENCE DRIVE INTERFACE SCHEME FOR HVAC PACKAGE	REV.NO.	00
		SHT 6	OF 6

SPECIFICATION FOR LOCAL CONTROL PANEL

	SPECIFICATION & DATA SHEET FOR LOCAL PANELS	
S.No.	PARAMETERS	REQUIREMENT
1	**CONSTRUCTION**	
	TYPE	FREE STANDING TYPE
	CONSTRUCTION	FOLDED
	DEVICES & EQUIPMENTS	PANEL ENCLOSURE, SECONDARY INSTRUMENTS, ANNUNICIATION SYSTEM, SELECTOR SWITCH, PUSH BUTTONS, INDICATING LAMPS/ LED CLUSTER, RELAYS, MCBs, CLAMP ON TERMINALS, PLUG SOCKET, PANEL LIGHT,
	ENCLOSURE SHEET MATERIAL	COLD ROLLED SHEET STEEL
	ENCLOSURE SHEET THICKNESS	MINIMUM 3.0 mm FOR LOAD BEARING SECTIONS (MOUNTED WITH INSTRUMENTS)
		2.0 mm FOR DOORS
		MINIMUM 2.0 mm FOR OTHER SECTIONS
	HEIGHT	MINIMUM 1100 mm
	FRAME THICKNESS	MINIMUM 3.0 mm
	INTERNAL PLATE THICKNESS	2.5 mm
	GLAND PLATE THICKNESS	3.0 mm
	CABLE GLAND	DOUBLE COMPRESSION, REMOVABLE AND GASKETED GLAND PLATE
	BASE CHANNEL	ISMC 100 WITH ANTI-VIBRATION MOUNTING & FOUNDATION BOLTS
	ANTI VIBRATION PAD SIZE	MINIMUM 15mm
	CLASS OF PROTECTION	IP-55 / IP-65 (AS PER THE REQUIREMENT)
	DOOR LOCKS	ACTUATION OF ALL LOCKS WITH A SINGLE MASTER KEY
	DOUBLE DOOR	TO BE PROVIDED WHERE PANEL WIDTH >= 800mm
2	**POWER & CONTROL SUPPLY**	
	INPUT POWER SUPPLY	415V 3 PHASE AC
	NO. OF FEEDERS	TWO
	CONTROL SUPPLY	230V AC
	ADDITONAL REQUIREMENT FOR CONTROL SUPPLY	MCBs
		SUPERVISORY RELAY ALONG WITH A PILOT LAMP TO INDICATE CONTROL SUPPLY 'ON'
		AUTO CHANGEOVER UNIT MOUNTED ON PANEL
3	**INTERNAL WIRING**	
	VOLTAGE	1100 V
	MATERIAL	PVC INSULATED COPPER
	ROUTING AND RUNS	THROUGH PVC TROUGHS, AC & DC WIRES SHALL BE KEPT SEPARATELY
	COLOUR	SEPARATE COLOURS FOR AC & DC WIRES
	SIZE	0.75SQMM FOR LOW VOLTAGE SIGNALS, 1.5SQMM FOR DO IGNAL, AMMETER/ VOLTMETER CIRCUIT, CONTROL SWITCHES, INDICATOR, RECORDER, 2.5SQMM FOR INTERNAL ILLUMINATION
	POWER CABLE SIZE	2.5SQMM FOR 1-16A, 4.0SQMM FOR 17-20A, 6.0SQMM FOR 21-32A, 10.0SQMM FOR 33-40A
	FERRULING	CROSS FERRULING
4	**PAINTING DETAILS***	
	PAINTING SHADE & THICKNESS - EXTERIOR	RAL 7032/RAL 7035 & MINIMUM 85 MICRONS
	PAINTING SHADE & THICKNESS - INTERIOR	GLOSSY WHITE TWO COATS/ RAL 7035 & MINIMUM 70 MICRONS
	*THESE DETAILS SHALL BE DECIDED DURING DETAILED ENGINEERING	
5	**GASKET**	
	AT DOOR & REMOVABLE COVER	NEOPRENE
6	**VENTILATION SYSTEM ALONG WITH LOUVERS & FILTERS**	
	COOLING FAN	2 X 100%, COVERED WITH REMOVABLE WIRE MESH

S.No.	PARAMETERS	REQUIREMENT
7	**TERMINAL BLOCK**	
	TYPE	CLIP ON , SEPARATE FOR AC & DC CIRCUITS, RAIL MOUNTED
	VOLTAGE	1100 V
	TB POINTS	CAGE CLAMP
	MOUNTING HEIGHT FROM FINISHED FLOOR	>=250 mm
	SPARE	20%
	IDENTIFICATION STRIP	WHITE MARKING STRIP
8	**ILLUMINATION**	
	LIGHT	LED TUBELIGHT
	SHROUDED COVER	15W MINIMUM
	OPERATING POWER SUPPLY	240V 50 Hz AC
	POWER SOCKET	6 POINT 6/16A, 240V 50 Hz AC UNIVERSAL
	OPERABLE THROUGH	PANEL DOOR SWITCH IN AUTO ON/OFF MODE
	POWER RECEPTACLE	15 Amp, 3-PIN
	SPARE	100% SPARE LED LAMPS
9	**EARTH BUS**	
	MATERIAL	COPPER
	SIZE	25/50x6 mm
	LOCATION	RUNS THROUGH PANEL WIDTH
	TERMINATION TO MAIN STATION EARTH	INTERNALLY WITH 10 MM BOLTS AT EXTREME ENDS FOR CONNECTION
	GROUND BUS CONNECTION AT EACH END	GROUND LEAKS (6mm x 50mm GI FLATS) BY SUITABLE BOLTING
	ELECTRONIC EARTHING RESISTANCE	<0.5 OHMS
	CIRCUIT CONNECTIVITY TO PANEL GROUND BUS	RING TORQUE TYPE COMPRESSION LUGS
	CONNECTIVITY TO PANEL MOUNTED EQUIPMENT/DEVICES - CONDUCTOR SPECIFICATION	GREEN COLOURED
		PVC INSULATED STRANDED COPPER
		2.5 MM2 SIZE
10	**ALARM ANNUNCIATOR SYSTEM**	
	NO. OF WINDOWS	MINIMUM 20
	FACIA	SOLID STATE DISCRETE
	HOOTER	10W
	ANNUNCIATOR SPARE (WITH ELECTRONICS)	10% SPARE WINDOW OR MINIMUM 2NOS. WHICHEVER IS MORE
	LAMP TEST PROVISION	REQUIRED
11	**NAME PLATE**	
	INSCRIPTION DESIGN	BLACK LETTERS ON WHITE BACKGROUND ON POLYAMIDE SHEET
	LABEL FIXATION	STAINLESS STEEL PANHEAD SCREWS

S.No.	PARAMETERS	REQUIREMENT
	NOTES FOR LOCAL CONTROL PANEL	
1	The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The doors shall be provided with suitable stiffeners to prevent buckling. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement. Door latches shall be of the three-point type to ensure tight closing.	
2	All operable and indicating devices shall be mounted on the front of the panel while aux. Relays, terminal, PVC trough, MCBs etc. required shall be mounted on a mounting plate inside the panel. The devices shall be located in such a way so as to ensure easy access for operation / maintenance.	
3	Suitable filler shall be applied to all pits, blemishes and voids in the surfaces. The filler shall be sand blasted so that surfaces are level and flat, corners are smooth and even. Exposed raw metal edges shall be ground burr free. The entire panel surface shall be sand blasted to remove rust and scale and all other residue due to the fabrication operation. Oil grease and salts etc. shall be removed from the panels by one or more	
4	Two spray coats of inhibitive epoxy primer – surface shall be applied to all exterior and interior surfaces, each coat of primer surfacer shall be of dry film thickness of 1.5 mil. A minimum of two spray coats of final finish colour (Catalysed epoxy finish) shall be applied to all surfaces of dry film thickness 2.0 mil.	
5	Paint films, which show sags, checks, blisters teardrops, fat edges or other painting imperfections, shall not be acceptable and if any such defects appear, they shall be repaired by and at the expenses of the Bidder.	
6	All panels shall be mounted on vibration dampers, which are secured to channels mounted on the floor. The channels shall be field welded to steel plates set into the concrete flooring. The steel plates shall be located such as to approximate the outline of panel bases. The exact mounting details shall be as approved by the owner during detailed engineering stage.	
7	All control and instrument wiring used within the panels shall confirm to NEC and NEMA standards and shall be factory installed and tested at the works of a qualified manufacturer. All interior wiring shall be installed neatly and carefully, and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrumentation leads, and all incoming and outgoing leads shall be connected to terminal blocks suitably located for connecting external circuits.	
8	All panel wiring shall have appropriate ferruling for clear identification. Interior wiring shall be so arranged that the external connections can be made with only one wire per terminal point. Any common connections shall be made internal side of the terminal blocks. Common connections shall be limited to two wires per terminal. Instrumentation cable shield wires shall be connected to separate terminal at the terminal block. Signal circuit shields shall be grounded separately.	
9	All internal wiring (except low level instrument wiring) shall be National Electric Code Type SIS, Polymetric/Elastomeric insulated, tinned copper stranded conductor, switchboard wire, or owner approved equal.	
10	The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.	
11	All panels shall be provided with adequate ventilation and packaging density of components shall be restricted so as to limit the temperature rise above ambient to 10°C under the worst conditions.	
12	Panel wiring shall have a flame resistant insulation with adequately sized 650/1100 V	
13	Wiring to door mounted devices shall be provided with (49 strand minimum) adequate loop lengths of hinge wire so that multiple door openings will not cause fatigue braking of the conductor.	
14	Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without unduly disturbing the wiring. No wire shall be routed cross the face or rear of any device in a manner, which will impede the opening of covers or obstruct access to leads, terminals or devices.	
15	Panel wires shall be identified with wire number and each termination by means of Action craft products split sleeve or Borden Chemical Co. indelible tubing markers or owner approved equal. Corrections and modifications of all panel wiring shall be Bidder's sole responsibility. Any corrections/modifications required at site for successful commissioning shall be done by the Bidder without any additional costs. Terminal lugs furnished must be of the compression, insulated sleeve, half ring tongue type. Open-ended terminal lugs will not be accepted. Wires shall not be looped around the terminal screws or studs.	
16	Identification of conductors may be done by insulation colour coding identified on drawings or by printed wiring lists.	
17	All fuses shall be fast acting semiconductor types for AC supply and compatible to the UPS fuses. For all DC Powered devices, similarly the fuses shall be fast acting compatible to DCDB fuse provisions. All the AC power supplies shall be provided with the protection of Fast acting semi conductor fuses & 2 P thermomegnetic type MCB. Make of Fuses shall be GE or Siemens. For all the DC power supply circuits, electronic type DC MCB shall be used only. Make of DC MCB shall be Siemens, Phoenix contacts, Murr, Weidmuller, or Lutze. 50 % spare fuses shall be provided with each panel, these are in additional to mandatory spares.	
18	Moulded case circuit breakers used in equipment covered under these specifications shall have not less than 5000 amp. Interrupting capacity at 220 Volts DC 10,000 Amp. Symmetrical interrupting capacity at 240 Volts AC. MCCB shall be provided at each main feeder line like ACDB & DCDB main feeders, PLC main feeder, control panels, UPS circuits etc.	
19	All markers/labels shall be made of halogen & silicon free polyamide material with inflammability class V2 as per UL 94, ensuring scratch proof printing with the use of environment friendly solvent free ink & latest BLUEMARK UV technology so as to comply the WIPE RESISITANCE according to DIN EN 61010-1/VDE 0411-1.	

APPLICABLE CODES AND STANDARDS

REFERENCE CODES AND STANDARDS FOR CONTROL AND INSTRUMENTATION		
Temperature Measurement		
1.	Performance Test Code for temperature measurement	ASME PTC 19.3 (1974 – R 1998)
2.	Temperature measurement -Thermocouples	ANSI-MC 96.1 – 1982, IEC 584
3.	Temperature measurement by electrical resistance thermometers	IS-2806
4.	Thermometer-element-platinum resistance	IS-2848, IEC 751/DIN 43760
5.	RTD Design Code	DIN EN 60751, BS EN 60751
6.	Thermowell Design Code	ASME PTC 19.3 TW
Pressure Measurement		
1	Performance Test Code for pressure measurement	ASME PTC 19.2 (2010)
2	Bourdon tube pressure and vacuum gauges	IS 3624, IS 3602, ASME B 40.1
Electronic measuring Instruments & Control hardware		
1.	Automatic null balancing electrical measuring instruments	ANSI C 39.4 (Rev. 1973), IS 9319
2.	Safety requirements for electrical and electronic measuring and controlling instrumentation	ANSI C 39.5 -1974
3.	Compatibility of analog signals for electronic industrial process instruments	ISA-S 50.1:ANSI MC 12.1 -1975
4.	Dynamic response testing of process control instrumentation	ANSI MC 4.1 (1975), ISA-S26 (1968)
5.	Surge withstand capability (SWC) tests	ANSI C 37.90A (1974) IEEE Std. 472 (1974), IEC – 255.4.
6.	Printed circuit boards	IPC TM-650, IEC 326 C
7.	General requirements and tests for printed wiring boards	IS 7405 (Part-I)
8.	Edge socket connectors	IEC 130-11
9.	Requirements and methods of testing of wire wrap terminations	DIN 41611 Part-2
10.	Dimensions of attachment plugs & receptacles	ANSI C73-1973
11.	Direct acting Electrical Indicating Instruments	IS-1248-1968
Instrument Switches, Contacts and Limit Switches		
1.	Contact rating -AC services	NEMA ICS Part-2 125, A600
2.	Contact rating -DC services	NEMA ICS Part-2-125, N600
3	Control circuit devices and switching elements	IEC-60947-5-1
Enclosures		
1.	Types of enclosures	NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13)
2.	Racks, panels, and associated equipment	EIA: RS-310-B (ANSI C83.9 -1972)
3.	Protection Class for Enclosure, Cabinets, Control Panels and Desks	IS-13947- 1962
4	Conductor Clamping	IEC – 60947-1 & IEC-60947-7-1.
Annunciators		
1.	Specifications and guides for the use of general purpose annunciators	ISA RP18.1-1979.
2.	Surge withstand capability tests	ANSI C.37.90a -1974 and IEEE std. 472-1974
Interlocks, Protections		
1.	Relays and relay system associated with electric power apparatus	IEEE std.3.13.
2.	Surge withstand capability tests	ANSI C.37.90a 1974 and IEEE Std. 472 1974
3.	General requirements & tests for switching devices for control and auxiliary circuits including contactor relays	IS-6875 (Part-I) 1973.
4.	Turbine water damage prevention	ASME -TDP-1980.
5	Boiler safety interlocks	NFPA Section 85B, 85D, 85E, 85F,85G.
Process Connection and Piping		
1.	Codes for pressure piping power piping	ANSI B31.1
2.	Seamless carbon steel pipe	ASTM A-106
3.	Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts	ASTM A-182
4.	Material for socket welded fittings	ASTM A-105
5.	Seamless ferrite alloy steel pipe	ASTM A-335
6.	Pipe fittings of wrought carbon steel and alloy steel	ASTM A-234
7.	Composition bronze or metal castings	ASTM B-62
8.	Seamless copper tube, bright annealed	ASTM B-168
9.	Seamless copper tube	ASTM B-75
10.	Dimensions of fittings	ANSI B-16.11
11.	Valves flanged and butt welding ends	ANSI B16.34
12.	Nomenclature for Instrument tube fittings	ISA-RP-42.1 -1982

Instrument Tubing		
1.	Seamless carbon steel pipe	ASTM -A106
2.	Material for socket weld fittings	ASTM -A105.
3.	Dimensions of fittings	ANSI B16.11
4.	Code for pressure piping, welding, hydrostatic testing	ANSI B31.1.
VFD		
1	Essential ratings and characteristic of semi-conductor devices	IS-3700
2	Letter symbols for semi-conducting devices	IS-3715
3	Code of designation of semi-conducting devices	IS-4411
4	Guide for preparation of drawings for semi-conductor devices	IS-5001
5	Code of practice for the use of semi-conductor junction devices	IS-5469
6	Transformers and indicators for electronic equipment	IS-6297
7	Performance parameters for motors	IS-8789
8	Switchgear and control gear for voltages exceeding 1000V- General Requirements	IS-12729
9	Code of practice for the selection, installation and maintenance of electricalapparatus for use in potentia	IS-13408
10	Semi Conductor converters	IEC 60146
11	Dimension of panels and racks	IEC 60297
12	General requirements and measuring methods for printed wiring boards	IEC 60326
13	Solder less wrapped connection	IEC 60352
14	Protection standards for converters	IEEE 444
15	Harmonic control & reactive compensation of static power converters	IEEE 519

QUALITY ASSURANCE
&
TESTING

CHAPTER-14

QUALITY ASSURANCE AND TESTING AND GUARANTEES

14.01.00 GENERAL REQUIREMENT

14.01.01 All equipment furnished under this specification shall be subject to test by authorized quality assurance personnel of the Bidder, representatives of the Owner during manufacture, erection and on completion. Bidder'' quality assurance personnel for these shop and site tests shall be identified in advance and shall be acceptable to the Owner. The approval of the Owner or passing of such inspection of tests will not, however, prejudice the right of the owner to reject the equipment if it does not comply with the specifications when erected or fails to give complete satisfaction in service.

14.01.02 The Bidder shall furnish details of shop and site tests proposed to be conducted by him at various stages to meet the specification requirements for each type of instrument/system along with his proposal. Bidder shall also furnish details of his proposed shop and site quality assurance organization for this contract

14.01.03 Bidder shall prepare a detailed shop and site 'Quality Assurance Programme' to meet the requirements of these specifications for Owner's approval. This document shall also contain the formats for reports and maintenance of test records specification of test equipment to be used for site tests.

14.01.04 All equipment and systems furnished under this specification shall be subjected to shop & site tests in accordance with the Quality Assurance Program approved by the Owner and shall be adequate to ensure full compliance with these specification, all applicable codes & standards and detailed engineering drawings and documents approved by the Owner.

14.01.05 The Bidder shall provide all required test equipment and simulation devices for performing all shop and site tests. All tests equipment shall be of reputed make, required accuracy class and shall be recently calibrated. The record of calibration of test equipment shall be made available to the Owner on demand.

14.01.06 The cost of all tests as per the requirements of this specification and approved quality assurance programme shall be included in Bidder's lump sum price for this package and no extra price shall be payable by the Owner for conducting any test as per the intent and requirements of this specification.

14.01.07 All approval/Inspection are to be carried out by the Owner only.

14.02.04.21 **Calibration of Instruments**

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

i TESTS TO BE PERFORMED FOR FIELD INSTRUMENTS

1.	Pressure Gauges
	Calibration Hydro test (1.5 times max. pr.)
2.	Pressure switches
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	Differential Pressure Gauges
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	Differential Pressure Switches
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	Thermometers
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	Temperature switch
	Calibration / Material test / Accuracy test / Bore concentricity : 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	Resistance temperature detector assembly.
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) as per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	Thermocouple assembly
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity : $\pm$ 5% of wall thickness.
9.	Thermowells
	Material test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)

10.	Level Guages
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	Level switches (Magnetic)
	Material test / Contact rating test / Hydro test / Calibration test.
12.	Flow Switch
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	Flow glasses
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	Variable area flow meters
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	Flow element
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	Control valves/Pneumatic block valve/Pressure regulating valve – Refer chapter 11.
17.	Position transmitters
	Calibration / hysteresis and Accuracy test
18.	Electro Pneumatic Convertors
	Calibration test / Accuracy test
19.	Solenoid valves
	Hydrotest / Seat leakage test / CV test / Coil insulation test
20.	Air filter regulators
	Calibration test / Accuracy test
21.	Junction Boxes
	Test for degree of protection / Material test
22.	Tests for terminal blocks
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	Thermocouple extension cable
	Thermo-emf characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	Mass flow meter
	Performance test / Calibration test / Hydrostatic test.
25.	Boiler Level Gauge
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	pH/Conductivity measurement / Silica / Dissolved oxygen analysers:
	Calibration test, Accuracy test
27.	Sample cooler :

	Hydro test, IBR Certificate
28.	Sampling racks :
	Hydro test, IBR Certificate for tubes and fittings.
29.	S02 / Nox analyser / SPM analyser:
	Calibration test, accuracy test
30.	Interposing relay
	Functional test, temperature rise test, H.V test, Insulation test
31.	Transmitter Racks :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	Pressure Transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	Differential pressure transmitter
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	Temperature Transmitter
	Calibration test / Accuracy test /Ambient temperature error test
35	Pneumatic Block Valves
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	Pressure Regulating Valve

	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 DegC) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	Local Panels : Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	Wiring Termination & Accessories
	Routine test: Conductor resistance test/High voltage test/Impulse dielectric test/insulation test/Humidity test/Temperature rise test on power circuits/short time current test on power circuits.
	Type test:Annealing test/Test for insulation and sheath/ Flame retardance test - a) Oxygen index, b) Flammability / Test for acid gas generation/test for water absorption/wet dielectric test
39	Marshalling/System cabinets
	Verification of degree of protection/Electrical tests as detailed under wiring Termination& accessories/Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner.
	3. In addition to above test, test as per approved QAP shall also be witnessed by owner.

TYPE TEST REQUIREMENT	
1	The Bidder shall furnish the Type test reports of all type tests as per relevant standards and codes.
2	For the type test to be conducted as per specification, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, acceptance norms (wherever applicable), recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.
3	For the type test not to be conducted, results, and certificates shall be acceptable provided following points are met: i. The same have been carried out by the bidder/ sub-vendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design). ii. There have been no change in the components from the offered equipments and tested equipments. iii. The test has been carried out as per the latest standards along with amendments as on the date of bid opening.
4	In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.
5	The schedule of conduction of type test/submission of reports shall be submitted and finalized during pre award discussion.

TYPE TEST

S.No.	Item	Test requirement	Standard	Test to be specifically conducted	Owner's Approval required on Test Certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS -13947	No	No.
3	Junction Box	Degree of Protection Test	IS -13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447/IEC 60770	No	Yes
6	Local gauges	Degree of protection test	IS 13947	No	No
7	Process actuated switches	Degree of protection test	IS 13947	No	No
8	PLCs	As per Standard	IEC 1131	No	YES
9	LIE/LIR	Degree of protection test	IS 13947	YES	YES
10	Flow Orifice plates	calibration	ASME PTC BS 1042	YES	YES

LIST OF TESTS TO BE CONDUCTED FOR VFD

1. Tests on Power Semiconductors

All power semiconductors selected shall be subject to quality assurance tests to check on the characteristics submitted by the successful bidder on samples. The contractor and/or his sub-vendor shall allow Owner's authorised representative to witness the tests. Details of the test are to be agreed between the Owner and the Contractor. The broad outlines of the tests to be conducted are as follows:

a) Off state voltage and reverse voltage
b) Critical rate of rise of off state voltage
c) On state voltage
d) Thermal resistance
e) Surge on-state current.
f) Triggering data
g) Recovery charge and recovery time
h) Critical rate of rise of on-state current
i) Switching losses
j) Environmental Tests

2. Tests on Converters

Converter with its enclosure and cooling system shall be connected to a dummy load. A variable voltage source on the source side shall be adjusted so that the specified current rating of the converter at no-delay of the firing angle (in case thyristors) shall be passed. At the end of stipulated period of test a timer shall cut-off the source. The load side and source side current shall be measured/recorded during the testing phase. The temperature of the case and the heat sink and wound components like chokes shall be suitably recorded. The temperature decay measurement/recording shall continue for the off-duty cycle at agreed intervals. During the course of test the cooling system shall be operative. The following tests shall be conducted:(IEC 61800-2)

a) Checking of the setting of the protection devices and their functioning.
b) Checking of the auxiliary devices and their functioning.
c) Speed regulation of the drive shall be observed at different output voltage and frequency settings (for AC drives).
d) Determination of the power losses at specified loads (By Calculation).(Type Test)
e) Load test or rated current test for large converters (above 1 MW).
f) Insulation test
g) Temperature rise (Type Test).
h) Light load & Functional Test.
i) Observation of various wave forms i.e. current and voltage.

3. Other Composite Test at No-load

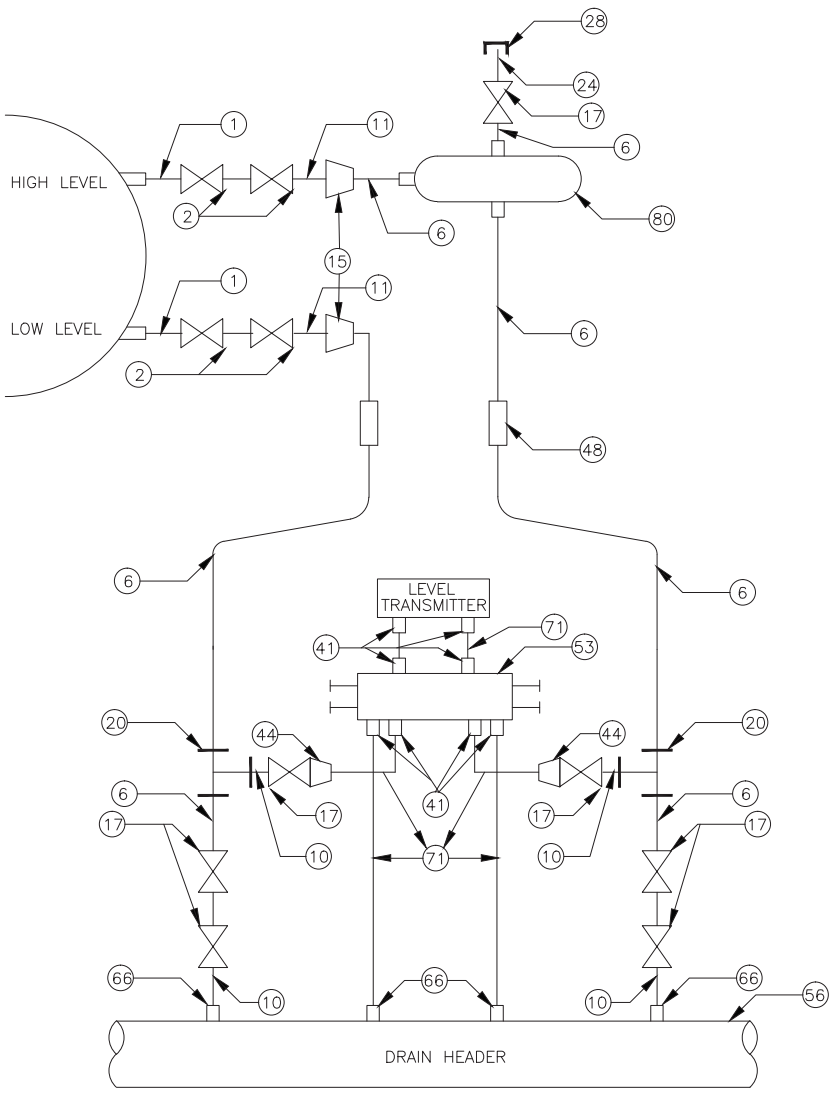
a) Environmental tests on printed circuit boards, pulse transformers etc.
b) Other tests as may be agreed on various converter subsystems.

4. Acceptance Test

These shall be conducted at the works of the Manufacturer's and/or his sub-vendor to ascertain that performance stipulated in this specification has been honoured (e.g. overcurrent capability, measurement of ripple voltage & current, P.F. measurement, Audible noise, etc). Dummy loads as required for the purpose of simulating the operation conditions at the manufacturer's works shall be considered in scope of this specification. However, should this not be possible, testing at site with the actual load shall be conducted to prove the performance of the power converters.

5. All the meter, instruments, devices used for the testing purpose shall be properly calibrated by standard authorised agencies which shall be traceable to National Standards. For each such instrument proper validity of calibration shall be documented by Contractor/sub-contractor.

INSTALLATION DRAWINGS



TRANSMITTER MOUNTED BELOW INST. SOURCE POINT

TAG NO.	DESCRIPTION	BOM
80	CONDENSATION CHAMBER	1
71	1/2"OD IMPULSE TUBE, SS-316	AS REQD.
66	1/2" GI SOCKET / FUNNEL	4
56	2"NB GI DRAIN HEADER	AS REQD.
53	5-VALVE MANIFOLD, SS-316	1
48	1/2" SW, CS/AS BULK HEAD PIPE UNION	2
44	1/2"BWX1/2"OD COMPRESSION TUBE FITTING,SS-316	2
41	1/2"NPT(M)X1/2"OD TUBE COMPRESSION FITTING,SS-316	8
28	1/2" NPT (F) CS CAP	1
24	1/2" NPS SCH-80/160X1/2"NPT(M) CS/AS NIPPLE	1
20	1/2" SOCKET WELDED EQUAL TEE CS/AS	2
17	1/2" SOCKET WELDED CS GLOBE VALVE	7
15	1"TO 1/2" SOCKET WELD REDUCER	2
11	1" NPS SCH 80/160 CS/AS NIPPLE	2
10	1/2" NPS SCH 80/160,CS/AS NIPPLE	4
6	1/2" NPS SCH 80/160 CS/AS PIPE	AS REQD.
2	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
1	1/2" NPS SCH 80 NIPPLES OF MATERIAL SAME AS MAIN PIPE WITH NECESSARY ATTACH TO FLANGES	AS REQD.

NOTE:-
1. FOR HIGH TEMP. SERVICE (MORE THAN 80°C) A 'U' TUBE(REF. DWG NO. 114-04-0100) SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER
2. FOR HIGH PR.(MORE THAN 40kg/sqcm) ONE NO. OF ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2NO. DRAIN VLV. ARE ALSO

REFERENCE DRAWINGS.

NOTES
1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT LIE/LIR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	REVISIONS	DATE	APPROVED CIVIL	MECH.	ELEC.	C&I	H.O.D.
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DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.
TITLE :- INST. DRAWING FOR LEVEL TRANSMITTERS
FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRAWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
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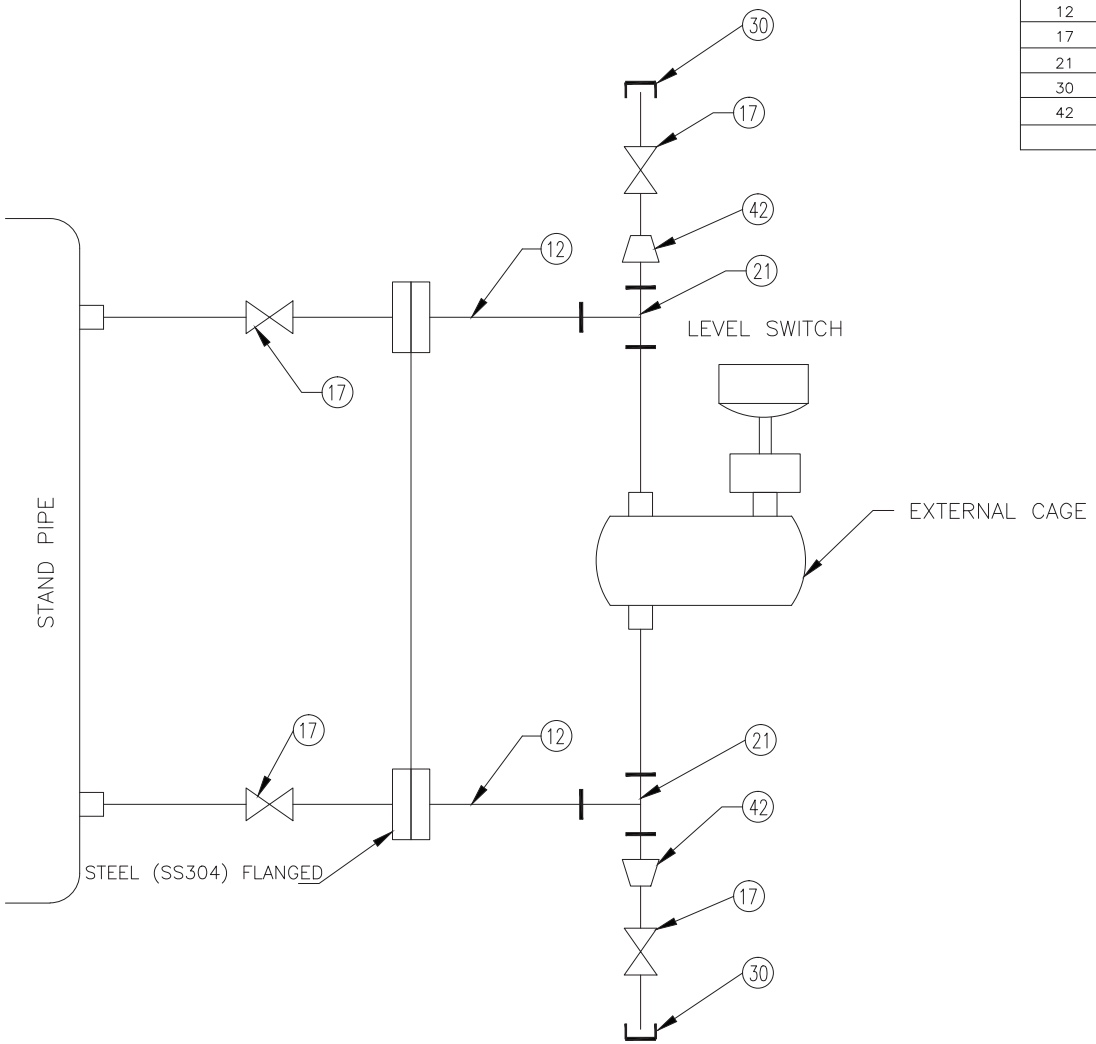
JOB. No. D-4027
DWG.No. 114-04-0110 REV. 0
Sheet No. 17 of 19

PAGE 99 OF 133

BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2



REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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	A	PRELIMINARY	25.04.13

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NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-1 WITH FLANGED CONNECTION

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
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Sheet No. 17 of 19

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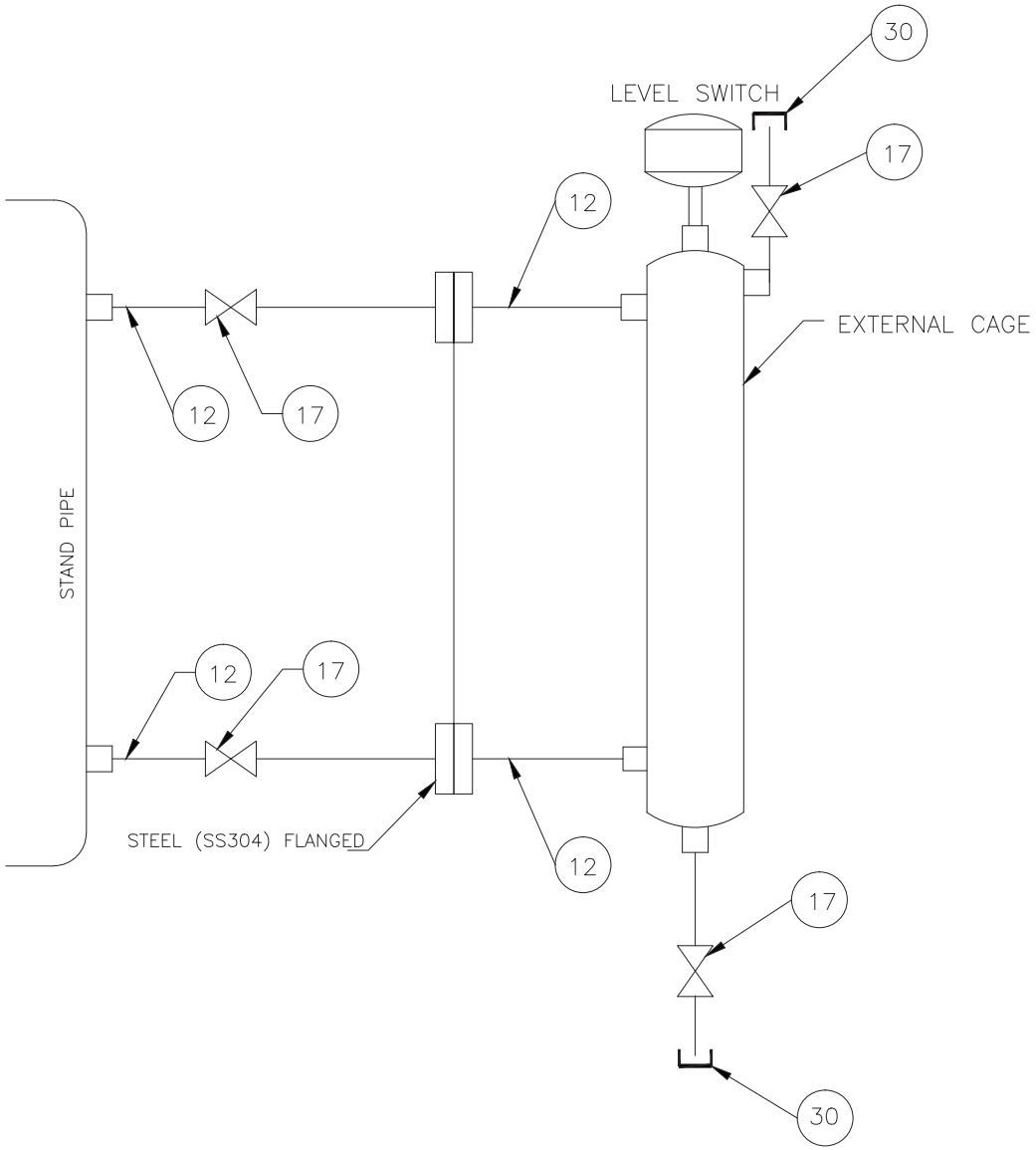

BILL OF MATERIAL		
TAG NO.	DESCRIPTION	QTY.
12	3/4" NPS SCH-80 CARBON STEEL PIPE	AS REQD.
17	1/2"/3/4"/1" SOCKET WELDED GLOBE VLV/ROOT VLV.	4
21	3/4" EQUAL TEE,CS	2
30	1/2" NPT (F) CS CAP	2
42	3/4"BW X 1/2"OD TUBE FITTING,SS-316	2

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. FLANGED CONNECTION ARE FOR LOW PRESSURE APPLICATION IN BOP PACKAGE ONLY.
4. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR LEVEL SWITCH OPTION-2 WITH FLANGED CONNECTION

FOR BID PURPOSE ONLY:

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CAD/DRWN	VIKAS		23.04.13
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DWG.No. 114-04-0113 REV. 0

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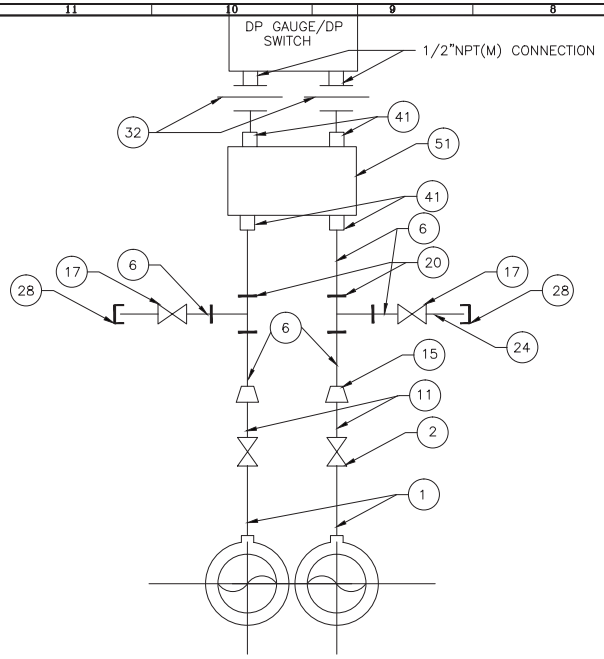
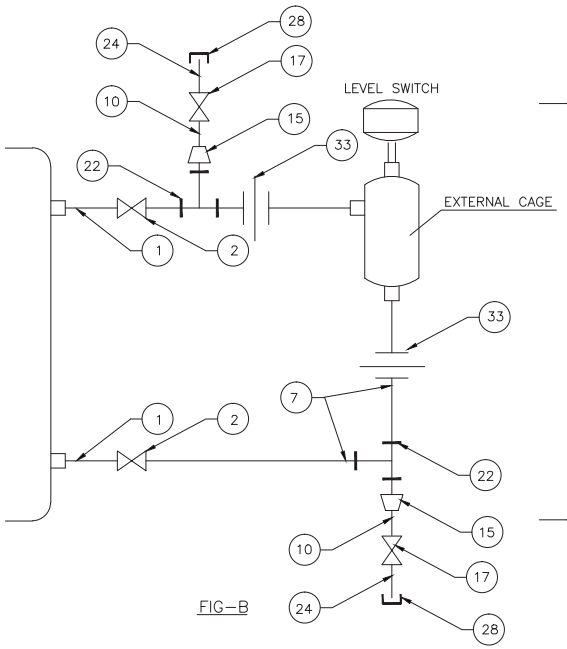
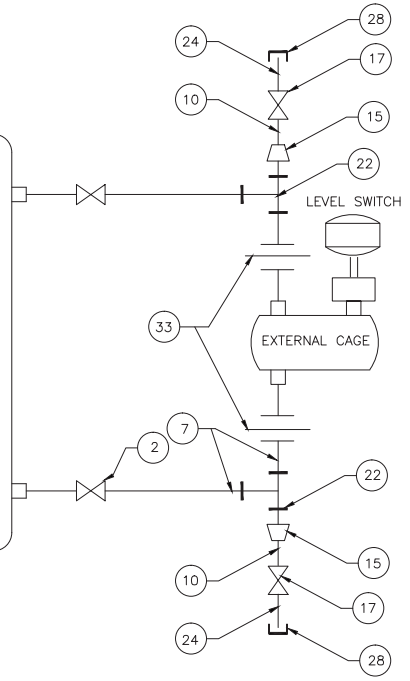


FIG–A



FIG–B



FIG–C

TAG NO.	DESCRIPTION	A	B	C
		QTY.		
78	1/2" NPT(F) X 1/2" NPT(M) SNUBBER/PULSATION DAMPNER	1	–	–
51	5 VALVE MANIFOLDS, SS–316	–	–	–
41	1/2" NPT(M) X 1/2" OD TUBE COMPRESSION FITTING,SS–316	–	–	–
38	3 WAY GAUGE VALVE 1/2"NB SW	1	–	–
33	1" SW EQUAL PIPE UNION	–	2	2
32	1/2" NPS,3 PIECE PIPE UNION 1/2" NPT(F) SCREWED AND 1/2" SW CONNECTION	1	–	–
28	1/2" NPT(F) CS. CAP	1	2	2
24	1/2" NPS,SCH 80/160 X 1/2" NPT(M) CS/AS NIPPLE	1	2	2
22	1" SW EQUAL TEE CS/AS	–	1	2
20	1/2"SW EQUAL TEE CS/AS	1	–	–
17	1/2" SW,CS/AS, GLOBE VALVE	1	2	2
15	1" TO 1/2" SOCKET WELD REDUCER	1	2	2
11	1"NPS SCH 80/160 CS/AS NIPPLE	1	–	–
10	1/2"NPS,SCH 80/160 CA/AS NIPPLE	–	2	2
6	1/2"NPS,SCH 80/160 CARBON/ALLOY STEEL PIPE	AS REQD.		
7	1" NPS,SCH 80/160 CS/AS STEEL PIPE	AS REQD.		
2	1/2"3/4"/1" ROOT VALVE – SW GLOBE VALVE	2	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL SAME AS THAT OF MAIN PIPE (AS PER PROCESS REQD.)	AS REQD.		

NOTE:–
WITH VALVE OF SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIERED

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER. ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION
PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI
TITLE :– INST. DRAWING FOR DIFF. PRESS. SWITCH/GAUGE/LEVEL SWITCHES
FOR BID PURPOSE ONLY

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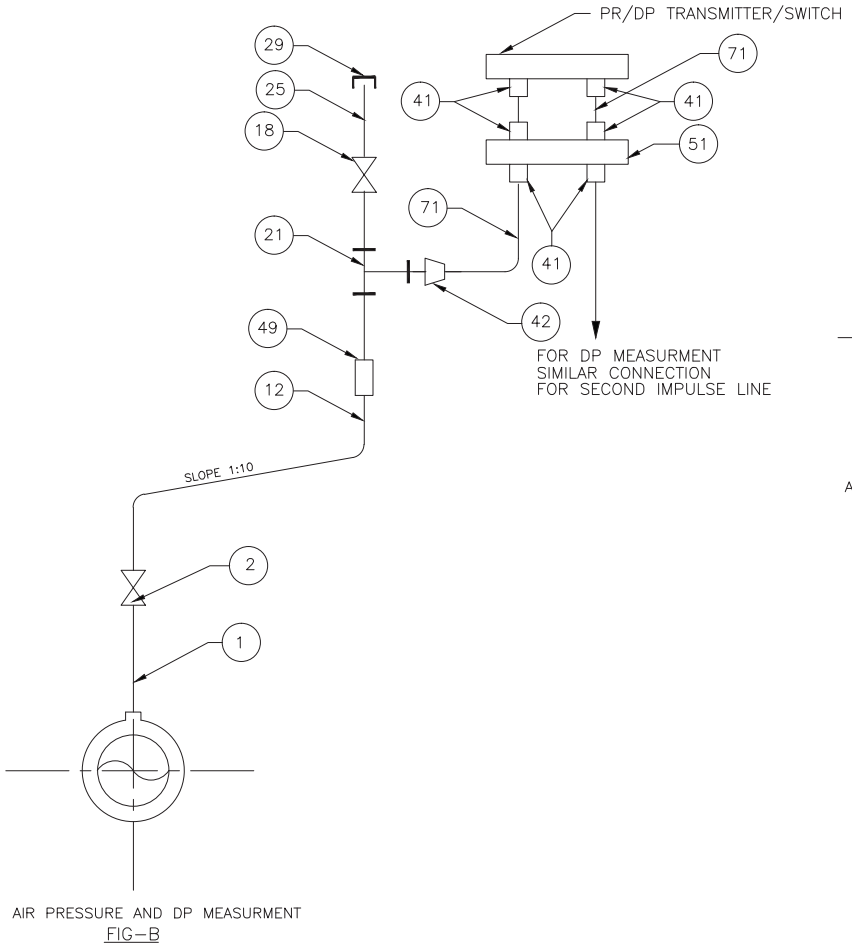
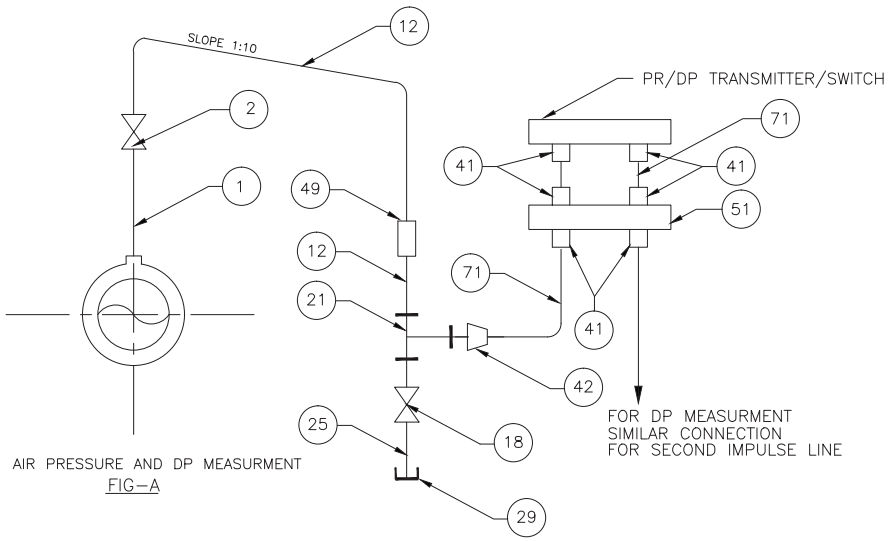


AIR PRESSURE AND DP MEASURMENT
FIG–B



AIR PRESSURE AND DP MEASURMENT
FIG–A

TAG NO.	DESCRIPTION	A	B
		QTY.	
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
51	5/3/2–VALVE MANIFOLDS,SS–316	1	1
49	3/4"SW,CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X 1/2"OD TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	6	6
29	3/4"NPT(F) CS CAP	1	1
25	3/4"NPS,SCH–80 X 3/4"NPS(M)CS NIPPLE	1	1
21	3/4" EQUAL TEE,CS	1	1
18	3/4" SW,CS GLOBE VALVE	–	1
12	3/4" NPS. SCH–80 CARBON STEEL PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE – SW GLOBE VALVE	1	1
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

NOTE:–

QUANTITY IN COLUMN A&B TO BE DOUBLED
FOR DP TAPPING EXCEPT ITEM NO. 51

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
4. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
5. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR PRESS. & DIFF. PRESS. TRANSMITTERS/SWITCH (AIR SERVICE)

FOR BID PURPOSE ONLY:

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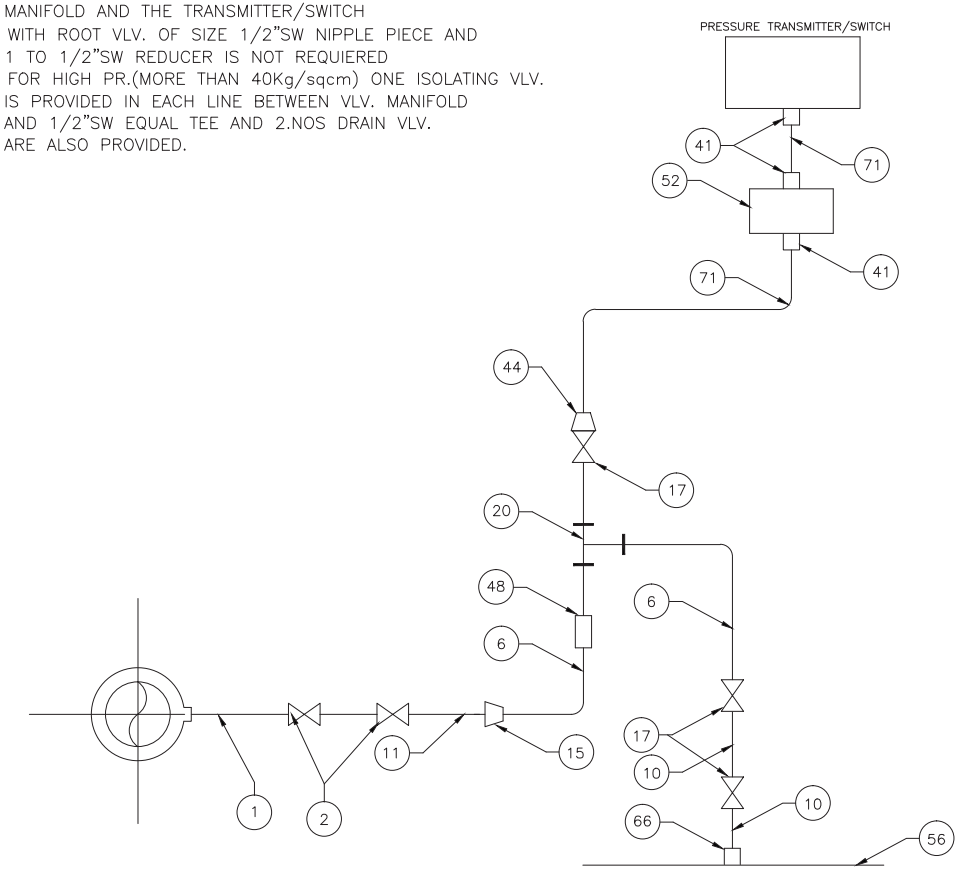
DWG.No. 114–04–0103 REV. 0

Sheet No. 5 of 19

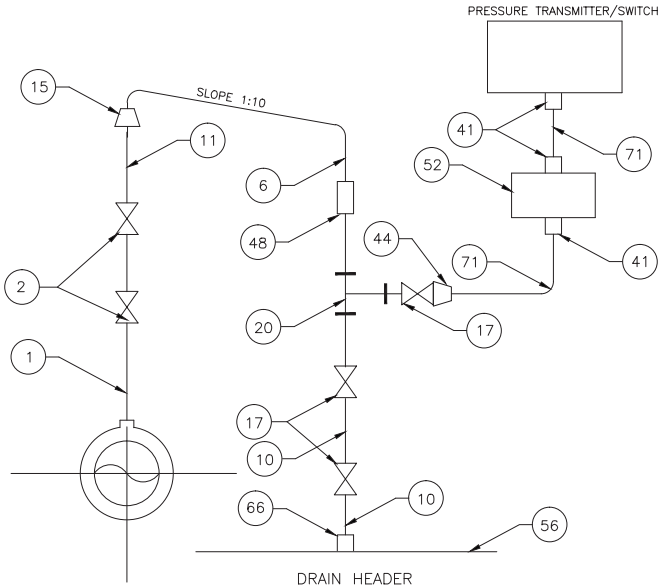
NOTE:–

1. FOR HIGH TEMP. SERVICE (MORE THAN *80C) A 'U'–TUBE / SYPHON (REF. DWG NO. IN–114–04–0100)SHALL BE PROVIDED BETWEEN THE MANIFOLD AND THE TRANSMITTER/SWITCH
2. WITH ROOT VLV. OF SIZE 1/2"SW NIPPLE PIECE AND 1 TO 1/2"SW REDUCER IS NOT REQUIERED
3. FOR HIGH PR.(MORE THAN 40Kg/sqcm) ONE ISOLATING VLV. IS PROVIDED IN EACH LINE BETWEEN VLV. MANIFOLD AND 1/2"SW EQUAL TEE AND 2.NOS DRAIN VLV. ARE ALSO PROVIDED.



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–D



TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT

FIG–C

TAG NO.	DESCRIPTION	QTY. C	QTY. D
71	1/2"OD IMPULSE TUBE,SS–316	AS REQD.	
66	1/2" GI SOCKET	1	1
56	2"NB GI DRAIN HEADER		
52	5/3/2–VALVE MANIFOLDS,SS–316	1	1
48	1/2"SW,CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X 1/2"OD COMRESSION TUBE FITTING,SS–316	1	1
41	1/2"NPT(M) X 1/2"00 TUBE COMPRESSION FITTING,SS–316	3	3
20	1/2"SW EQUAL TEE,CS	1	1
17	1/2" SW,CS GLOBE VALVE / NEEDLE VALVE	3	3
15	1" TO 1/2" SW REDUCER	1	1
11	1" NPS SCH–80 CS/AS NIPPLE	1	1
10	1/2" NPS,SCH 80/160, CS/AS NIPPLE	2	2
6	1/2" NPS. SCH–80/160 CS/ AS PIPE	AS REQD.	
2	1/2"/3/4"/1" ROOT VALVE	2	2
1	1/2"/3/4"/1" CARBON/ALLOY STEEL NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PER PROCESS REQD.)	AS REQD.	

BILL OF MATERIAL

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/I/R
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS / ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

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DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :– INST. DRAWING FOR PRESS. & DIFF.PRESS. TRANSMITTERS/SWITCH (STEAM & LIQUID SERVICE)

FOR BID PURPOSE ONLY:

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DESIGNED	SKM/SN		23.04.13
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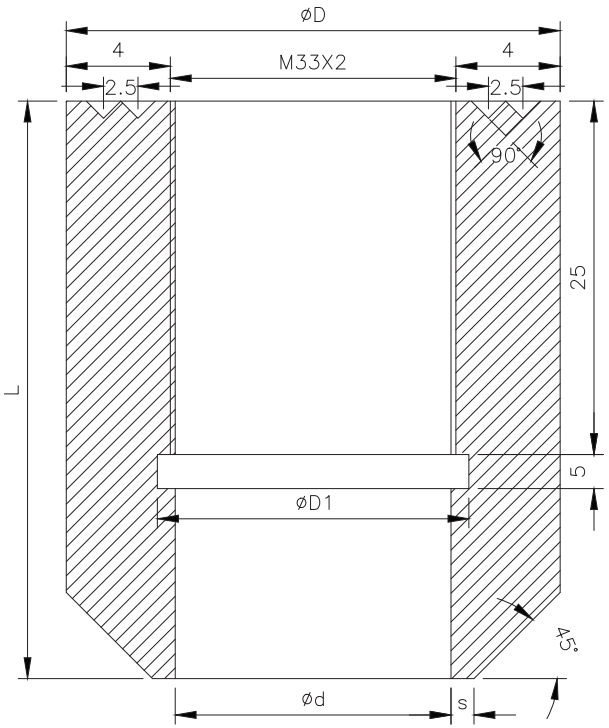
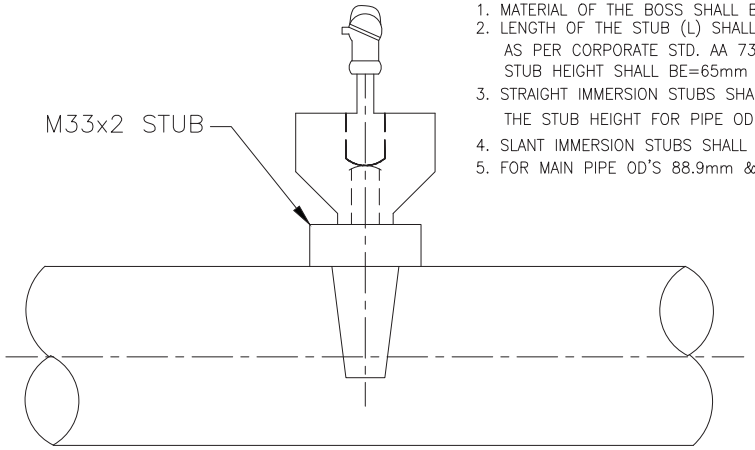


TEMPERATURE STUB FOR STRAIGHT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

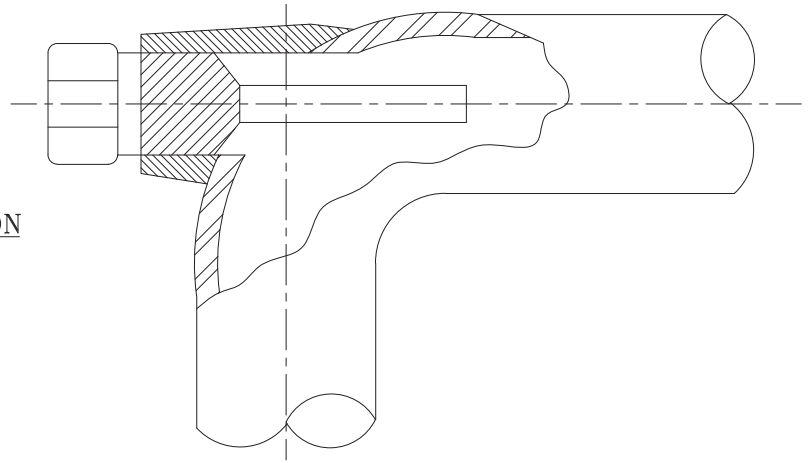
NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.



INSTALLATION TYPE-1

(FOR MAIN PIPE OD 168.3mm & ABOVE)



INSTALLATION TYPE-2

(FOR MAIN PIPE OD 88.9mm & BELOW)

REFERENCE DRAWINGS.	NOTES	NOTICE
	1. DO NOT SCALE, ASK WHEN IN DOUBT. 2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE. 3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/I/R 4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR. 5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING 6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.	

ZONE	MARK	REVISIONS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI - INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR TEMPERATURE STUB

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13

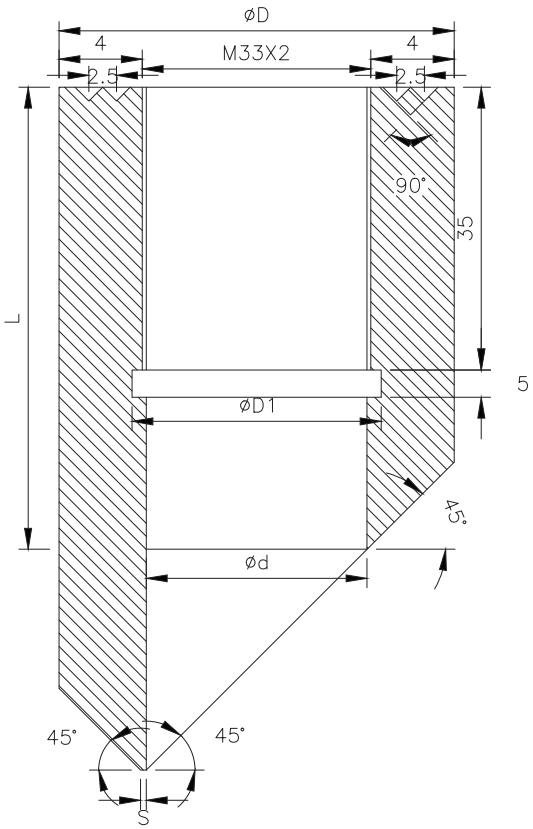
SCALE: N.T.S.

JOB. No. D-4027

DWG.No. 114-04-0111 REV. 0

SHEET No. 14 of 19

PRINT DISTRIBUTION: SR. No. PARTY

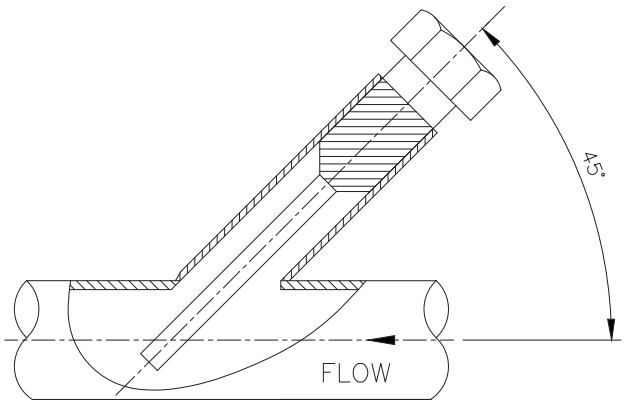


TEMPERATURE STUB FOR SLANT IMMERSION

FOR PIPE OD BELOW 219.1mm	29	55	33.5	1.5	65
FOR PIPE OD 219.1mm & ABOVE	29	55	33.5	1.5	45
MAIN PIPE SIZES	d	D	D1	S	L

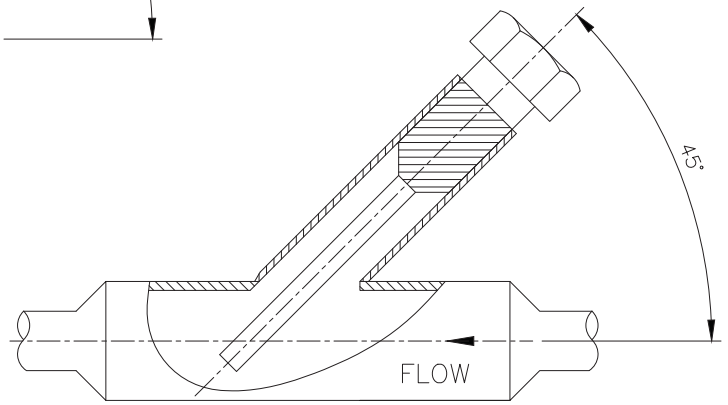
NOTE :-

1. MATERIAL OF THE BOSS SHALL BE THE SAME AS THE PIPE INTO WHICH IT IS WELDED.
2. LENGTH OF THE STUB (L) SHALL BE 65/45 mm DEPENDING UPON PIPE SIZE, AS PER CORPORATE STD. AA 7326102.(FOR PIPE OD 88.9mm TO 159mm STUB HEIGHT SHALL BE=65mm & FOR PIPE OD >219.1mm STUB HEIGHT SHALL BE=45mm)
3. STRAIGHT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 168.3mm & ABOVE. THE STUB HEIGHT FOR PIPE OD, 168.3mm TO <219.1mm SHALL BE 65mm.
4. SLANT IMMERSION STUBS SHALL BE USED FOR PIPE OD'S 88.9mm TO 159mm.
5. FOR MAIN PIPE OD'S 88.9mm & bELOW SUITABLE EXPANDER SHALL BE USED.



INSTALLATION TYPE-3

(FOR MAIN PIPE OD 88.9mm TO 159mm)



INSTALLATION TYPE-4

(FOR MAIN PIPE OD 88.9mm & BELOW)

REFERENCE DRAWINGS.

NOTES

1. DO NOT SCALE, ASK WHEN IN DOUBT.
2. ALL DIMENSIONS ARE IN MILIMETRES UNLESS NOTED OTHERWISE.
3. BULK HEAD FITTING SW TYPE SHALL BE PROVIDED AT I/E/IR
4. ABOVE DRWING IS FOR BASIC GUIDE LINE TO BE MEET BY BIDDER, ANY FURTHER IMPROVEMENT DURING DETAILED ENGINEERING SHALL ALSO BE CONFIRMED/PROVIDED BY CONTRACTOR.
5. QUANTITIES OF INSTRUMENTS/ ERECTION HARDWARE SHALL BE AS PER NIT AND AS FINALISED DURING DETAIL ENGINEERING
6. FOR DM PLANT MATERIAL OF ERECTION HARDWARE SHALL BE SS 316 ONLY.

NOTICE

ZONE	MARK	REVISIONS	DATE	CIVIL	MECH.	ELEC.	C&I	H.O.D.
	A	PRELIMINARY	25.04.13				SLN	

APPROVED

DESEIN
CONSULTING ENGINEERS
NEW DELHI – INDIA

CLIENT: TAMILNADU GEN. & DIST. CORPORATION

PROJECT: 2x660MW ENNORE SEZ COAL BASED SUPERCRITICAL THERMAL POWER PROJECT AT ASH DYKE OF NCTPS, CHENNAI.

TITLE :- INST. DRAWING FOR TEMPERATURE STUB

FOR BID PURPOSE ONLY:

	NAME	SIGN.	DATE
CAD/DRWN	VIKAS		23.04.13
DESIGNED	SKM/SN		23.04.13
CHECKED	S.K.M.		24.04.13
SCALE	N.T.S.		

JOB. No. D-4027

DWG.No. 114-04-0111 REV. 0

Sheet No. 15 of 19

PRINT DISTRIBUTION

SR. No. PARTY

VARIABLE FREQUENCY DRIVE (VFD)

1.0 DESIGN CRITERIA

1.1 Power semiconductors of reputed make either in stud mounting form or disc/flat pack type can be offered based on the duty requirements specified in technical specifications and to meet the technical and functional requirements.

1.2 The peak reverse voltage rating of each power semiconductor shall be as follows:

1.3 Power Semiconductors Protected by RC Snubber

The following factors of safety shall be observed:

a) For converters operating in : 2.0 times peak of the no load source rectifying mode only voltage

b) For converters operating both in rectifying And inverting modes : 2.5 times peak of the no load source

1.4 Power Semiconductors Protected by Avalanche Diodes

1.4.1 The contractor shall choose and recommend the factor of safety which however, shall not be less than 1.5.

1.4.2 The current rating of the power semiconductor shall be estimated for the specified duty class of the respective motor. In sizing the power semiconductor both the forward voltage drop and the forward resistance shall be considered.

1.4.3 A derating of approximately 20% shall be made to take into account series operation of devices.

1.4.4 The class of overload shall be one of the following:
Duty Class Rated current values for converter (in percent of rated direct current)

I) 100 % Continuous
II) 100 % Continuous
150 % overload for 1 minute once in period of 24 hours
III) 100% continuous
150 % overload for 2 minute once in period of 24 hours
200 % overload for 10 seconds once in period of 24 Hours

1.5 For the cases where the power semiconductor chosen is of inadequate current or voltage capacity the contractor shall conform to the following guidelines:

1.5.1 Inadequate Current Capacity

a) If the power semiconductor is of stud mounting type, then current sharing reactors shall be provided to prevent current mis-sharing between the power semiconductors connected in parallel.

b) If the power semiconductors in parallel are of capsule type, then, one of the following options may be exercised:

i) Power semiconductors with adequate derating and the layout configured so that current mis sharing between various power semiconductors in parallel is minimized.

ii) Selection of power semiconductors so that their forward voltages are within a tolerance band of 100 mV to 250 mV.

1.5.2 Inadequate Voltage Capacity

In this case the power semiconductors shall be connected in series with adequate protection to prevent irregular voltage grading across each power semiconductor during turn-on.

1.6 The converter shall be provided with adequate surge suppression circuitry at the AC input, DC output and across the devices to limit the main voltage surges, transformer switching surges, reverse recovery transients to less than twice the peak value of line working voltage.

1.7 Maximum noise level from the drive at 1-meter distance, under rated load with all normal cooling fans operating shall not exceed 85 dBA.

1.8 Motor space heater supply for approximate rating of 240 V, 400 Watts is to be provided in VFD Panel interlocked with VFD Run command i.e. when Motor is running, motor space heater shall be OFF and when motor is stopped, motor space heater shall be ON. In case of bypass mode operation of motor, a contact shall be taken from Bypass Mechanism so that logic for Space heater is ensured i.e. heater is ON when motor is stopped and vice-versa.

1.9 VFD should have by-pass system for running of motor on DOL in case of outage of VFD. Before changeover to DOL VFD shall give an alarm and VFD fail indication. The contractor shall submit the control/interlock scheme with equipment data sheet for owner's approval.

2.0 DRIVE OPERATION

The drive should be according to the no. of Quadrants that shall be provided for the respective motors depending on the motor application during detailed engineering.

A. The Quadrant Operation of the Drive will be according to the following criteria.

a) One Quadrant Operation -> (I): One Quadrant of operation means only Motoring is required & the drive should operate in the First Quad.

b) Two Quadrant Operation -> (II):- Two Quadrant Operation means the drive should be able to control the motoring & Braking of the motor. It can be of two types.

i) Voltage Positive & Current can charge Polarity i.e. operating in First & Second Quad.
ii) Current Positive & Voltage can charge Polarity i.e. operating in first & fourth Quad.

c) Four Quad Operation -> (IV):- The drive should be able to operate in all four Quadrant i.e. the motor requires forward motoring, forward braking, Reverse motoring & reverse braking.

3.0 CONTROL FOR DC MOTORS

3.1 Armature Voltage Control Converter

3.1.1 This converter shall consist of, unless otherwise stated, a three phase full wave bridge circuit.

3.1.2 Each arm of the bridge can have a number of power semiconductors both in series and/or in parallel. The design basis for such cases shall be in conformity with Clause 3.00.00 of this specification.

3.1.3 If the drive operates in the first quadrant only, a freewheeling diode may be provided for the purpose of allowing decay of energy during the condition of braking of the drive. This diode may be housed within the same cubicle as the bridge converter.

3.1.4 Redundancy shall be provided as follows:

a) For power semiconductors in parallel one additional parallel three phase full wave bridge arm shall be provided as redundant element.
b) For power semiconductors in series, at least 2% of the total thyristors in series for each parallel arm shall be provided.

The factors of safety to be observed in such designs shall be in conformity to Clause 1.0 of this specification.

3.2 Field Excitation Control Converter

3.2.1 Unless otherwise stated, this converter shall be powered from a single-phase line-to-line source tapped at the three-phase incomer to the armature voltage control converter with adequate isolation.

3.2.2 Unless otherwise stated, this converter shall be a bridge of diodes of adequate capacity.

3.3 Transducers

3.3.1 Armature Circuit

a) For drives where accuracy of speed control is better than 0.5%, the actual speed of the drive shall be measured by a tacho-generator of suitable rating, and type (Digital pulse tacho or analog tacho).

b) For drives where accuracy of speed control required can exceed 2% or more, measuring the current by a current transformer on the AC side of the converter can be accepted.

c) For drives whose accuracy of speed should not exceed 2% it is necessary that a suitable DC shunt of 75 mV and adequate current capacity shall be provided.

3.3.2 Field Circuit

For Drives where there is a possibility of field circuit failing, then in such case transducers should be provided.

4.0 FREQUENCY CONVERTERS FOR SQUIRREL CAGE INDUCTION MOTORS

4.1 Configuration

Frequency converters shall have one of the two configurations given below:

a) Current source inverter.

b) Voltage source inverter.

4.2 DC Link

4.2.1 Current Source Inverter

a) The smoothing reactor shall be sized to avoid conditions of discontinuous current operation of the frequency converter at its lowest frequency of operation, which shall not be less than 5 Hz.

b) The smoothing reactor shall be uniformly insulated and shall be protected for voltage surges occurring during sudden load throw-off.

c) The smoothing reactor shall be made from electrolytic grade copper/aluminium and shall be epoxy encapsulated with suitable class of resin decided from techno-economic considerations and performance requirements in conformity with IEC-60146.

4.2.2 Voltage Source Inverter

a) The smoothing reactor shall conform to requirements specified in Clause 4.2.1

b) The DC capacitor shall be shunt connected at the input to the inverter. It shall be sized so that the reactive power requirements of the motor during its total range of operation are met. Further, the following aspects shall be observed:

i) As per standards, the nominal value of capacitance referred to the temperature of 250C shall be within tolerance range of 10%. At the design ambient temperature, the value of capacitance and the tolerance range shall be such as to meet the normal operation/performance requirements of the frequency converter.

ii) As per standards, the dissipation factor of each unit of the capacitor shall be less than 1% at 250C. However, the design ambient shall be such as to meet the normal operational/performance requirements of the frequency converter.

iii) The impregnation material used for the capacitor shall be non-inflammable, non-PCB dielectric liquid.

iv) The voltage rating of each capacitor shall be selected based on considerations of life expectancy, overvoltage during regeneration of energy, design ambient temperature, ripple voltage etc.

4.3 Inverter

4.3.1 The inverter system suitable for three phase output shall consist of the following subsystems:

a) The basic inverter circuit consisting of the switching device say Thyristors/Transistors/IGBT/MOSFET, connected so as to supply three phase power.

b) The logic network to enable rapid transition of the main inverter switching devices from on-state to off-state.

c) Suitable feedback system to allow balance of reactive power flow during load power factor fluctuation as well as regeneration.

d) The filter system of the inverter output to suppress 5th, 7th, 11th, 13th harmonics at the output of the inverter to less than 5% of the fundamental amplitude.

e) The ripple control system to limit current ripple to 4% at the input terminals of the inverter caused by distorted current output.

4.3.2 The output frequency of inverter shall be controlled to within the limits specified in technical parameters.

4.4 Inverter for AC drive

4.4.1 Current Source Inverter

a) Constant Torque Operation

The current output by the DC link shall be accurately monitored so that the ratio of the terminal voltage of the motor and the corresponding frequency remains constant and the duty cycle requirements for the respective motors are met. Necessary protective features for tripping the frequency converter, alarm/annunciation and fault diagnostics shall be provided.

b) Constant Horsepower Operation

In this type of operation, the motor's internal voltage shall be maintained within + 1% while the frequency of the inverter is varied to meet the duty cycle requirements for the respective motors. Necessary protective features for tripping the frequency converter, alarm/annunciation and fault diagnostics shall be provided.

4.4.2 Voltage source Inverter

a) Constant Torque Operation

The DC voltage input to the inverter shall be accurately monitored to maintain the ratio the terminal voltage of the motor to frequency at the rated/design value so that the duty cycle requirements of respective motors are met. The DC voltage input shall be maintained within + 1% of the required value. Should this fall for any reason, necessary action for tripping the frequency converter and initiation of annunciation/alarm and fault diagnostic shall be provided.

b) Constant Horsepower Operation

In this type of operation, the voltage at the terminals of the motor shall be maintained within +1% of the rated value while the frequency of the inverter is varied to meet the duty cycle requirements for the respective motors. Necessary protective features for tripping the frequency converter, initiation of alarm/annunciation and fault diagnostic shall be provided.

4.5 Output Over current Limit

Unless otherwise stated, the inverter shall be capable of being temporarily overloaded to 150% of its full load ampere capacity for sixty (60) seconds beyond which a current limit action shall be initiated and an alarm contact initiated for annunciation.

4.6 Control Modules

4.6.1 All elements of the control system shall be mounted on epoxy laminate boards and each board shall be a plug in module mounted on a standard nineteen inch rack which shall be accessible from the front. Each card shall have LED indication on its front plate to indicate normal condition of the card. Readily accessible and clearly marked test pins shall be important points on the cards to enable signal analysis. The contractor/bidder shall furnish the signal input to the card.

4.6.2 The epoxy laminates shall be free from manufacturing errors and shall be designed to prevent incorrect insertion in the card rack. The copper side of the card shall be suitably. lacquered to prevent oxidation. The gap between two cards shall be sufficient to permit adequate ventilation.

4.6.3 Adjustments susceptible to change by accidental contact shall be lockable.

5.0 CONTROL REQUIREMENTS

5.1 Short time voltage dips up to 80% of nominal (e.g. in case of large motor startup connected to same bus) shall not cause the control system to stop functioning and shall not trip the drive system.

5.2 The drive motor shall be speed regulated corresponding to 4-20mA input signal. Upon complete loss of users speed reference signal, the drive shall automatically run at constant speed as determined by the last speed reference available prior to loss of the signal. The required provision for interfacing with DCS, including details of communication module and data transfer facility, I/O details shall be furnished by the contractor. Local / remote selector switch shall be provided.

6.0 PROTECTION

6.1 Protection of Power Semiconductor

a) Each power semiconductor shall be protected against short circuit. The fuse shall be sized so that its I^2t does not exceed the I^2t characteristic of the power semiconductor itself. The voltage and current rating of the fuse shall match the duty on the power semiconductor. The arc voltage, due to melting of the fuse shall not exceed the repetitive peak reverse voltage of the power semiconductor.

b) All fuses shall have a trip indicator to operate a suitable microswitch with at least 1 NO + 1 NC potential free contacts for annunciation and/or tripping.

c) A fast tripping feeder circuit breaker shall be used in case fuses for short circuit protection of thyristors are not used.

6.2 Protection of Converter System for DC Drive

6.2.1 Armature Circuit

The basic protections to be provided are as follows:

a) Earth fault relay
b) Thermal overload relay

Other optional protections not mentioned herein but are required for safe and reliable functioning of the system shall be considered in scope of supply.

6.2.2 Field Circuit

The basic protections to be provided are as follows:

a) Minimum excitation limit relay
b) Thermal overload relay
c) Earth Fault Relay

Other optional protections not mentioned herein but are required for safe and reliable functioning of the equipment/system shall be considered in scope of supply of contractor.

6.3 Protective Systems for AC Inverter Drive

a) Fuses for all power semiconductors and/or other devices like commutation chokes, capacitors etc. which are not adequately protected against flow of abnormal currents.

b) Under voltage and over voltage protection on the input side. Loss of input voltage to inverter shall entail tripping of the inverter.

c) Protection for all control cards, power supply stabilisers, filter circuits etc. Protection shall be provided such that failure of a part does not cause damage elsewhere in the system.

d) Polarising relay to prevent reversal of polarity on the input side of the inverter.

e) Protection of inverter thyristor, commutating circuits and other inverter elements during regenerative operation of the inverter and also during sudden load throw-off.

f) Besides the above, the following protective systems shall also be supplied

i) Current limit fuses at the output of the inverter.
ii) Commutation circuit under voltage
iii) Inverter over frequency.
iv) Programmable over current
v) Phase sequence/loss of phase protection.
vi) Earth fault protection
vii) DC link overvoltage protection
viii) Specific motor protection
ix) Incoming line surge protection
x) Ventilation Loss
xi) Over temperature

6.4 All controls, indication, Metering, Annunciation required on the Drive Panel shall be duly provided. Diagnostics shall be interfaced to DDCMIS.

7.0 COOLING OF POWER CONVERTERS

7.1 Power semiconductors shall be mounted on heat sink which can be individual or common to a number of devices. Adequate provision for clamping and mounting the power semiconductors shall be available.

7.2 Cooling of power semiconductors can either be natural air cooled or forced air cooled. The contractor shall recommend the type of cooling. However, for power converters which exceed capacities of 2 kA continuous load, alternative cooling methods as oil or water cooling shall be considered. The power semiconductors shall preferably be double side cooled.

7.3 All equipment required for safe and correct operation as drive motor, blower/pump, cooling water/oil header, water/oil distribution piping, de-ioniser system, flow monitors etc. as applicable shall be considered in the contactor's scope of supply.

8.0 SWITCHING DEVICES

8.1 Switching devices as circuit breakers, isolators, contactors; switch-fuse units etc. shall be supplied as required for safe and reliable working of the system.

8.2 The switching devices shall be enclosed in a separate enclosure forming the set of panels for the power converters. They shall have adequate clearance both with adjacent devices and metalwork at earth potential. Connection between devices shall be by adequate size of electrolytic grade of copper/aluminium strips. These connections shall be adequately braced and insulated.

9.0 CONSTRUCTIONAL FEATURES

The controller should have modular construction to facilitate maintenance.

9.1 Busbars

9.1.1 Power connections shall be of the bolted type and mating surfaces shall be tinned.

9.1.2 The bus bars running to various converters shall be suitably designed to ensure equal sharing between the parallel strings and prevent mechanical stress on the fuse.

9.1.3 All bus bars shall be adequately insulated for full circuit voltage by insulating tapes and similar insulating material.

9.1.4 In case aluminium bus bars are specified, care shall be taken to ensure that bimetallic connections are provided wherever necessary.

9.1.5 All cubicles shall have copper earth buses of adequate size running in the entire cubicle height along the sides with provision for connection to plant earth grid. All the non-metallic components / parts shall be connected to the main earth bus bar. Separate earth bus bar and stud for electronic control system shall be provided.

9.2 Cubicle

9.2.1 Cubicles housing the power semiconductors and drive level control system shall conform to IP 42 degree of protection to enclosures.

9.2.2 Panels shall be free standing, floor mounting type and shall comprise rigid welded structural frames enclosed completely with cold rolled sheet steel of thickness no less than 2.5 mm for front and rear portions and 2.0 mm for sides, top and bottom portions. There shall be sufficient re-inforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation.

9.2.3 All doors, removable covers and panels shall be gasketed all round with neoprene gaskets. Ventilating louvers shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

9.2.4 Design, material selection and workmanship shall be such as to result in a neat appearance inside and outside with no welds, rivets or belt heads apparent from outside, with all exterior surfaces true and smooth.

9.2.5 All the control wiring shall be enclosed in plastic / metal channel. Each wire shall be identified at both ends by self-sticking wire marker tapes or PVC ferrules. Power and control wiring inside the panel shall be done with BIS approved, PVC insulated, fire retardant, copper conductor wire 1.5 mm2 size wire shall normally be used provided the control fuse rating is 10 Amps or less and 2.5 mm2 size for control fuse rating 16 A & above for electrical circuits and 0.5 mm2 for electronic circuits. All wires shall be ferruled and terminals shall be properly numbered, minimum 20% spare terminal shall be provided.

9.3 Painting

9.3.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS: 6005 "Code of Practice for Phosphating Iron and Steel".

9.3.2 Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

9.3.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

9.3.4 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and even drying.

9.3.5 The phosphate coating shall be followed by the application of two coats of ready mixed stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.

9.3.6 After application of the two coats of primer finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests.

9.3.7 The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns.

9.3.8 Finished painted surface of panels shall present an aesthetically pleasing appearance free from dents and uneven surface.

9.3.9 A small quantity of finishing paint shall be supplied for minor touching up required at site after the installation of the panels.

9.4 Bins and Printed Circuit Cards

9.4.1 Individual bins shall be mounted on a swingable frame so that the connections at the rear are also accessible.

9.4.2 Self retaining thumb head screws shall be needed for holding the bins in position.

9.4.3 Adequate number of card/bin extenders for testing of PCBs shall be provided, each with flexible cables at least two metres long. These extenders shall be of a universal type suitable for use with any card / bin as the case may be.

9.4.4 All adjustments which are to be made while changing a card shall be outside in a separate module preferably plugged into the regulator bin.

9.4.5 Locking of individual cards in a bin shall preferably be through self-retaining thumb-head screws.

9.4.6 Control modules shall be in the form of plug in packages, plugged into a module bin. Each plug in unit shall consist of a strong frame on which a printed circuit board would be permanently screwed. The plug connections shall only be of the pin type.

9.4.7 The printed circuit board (P.C.B.) shall be made of glass fibre filled with epoxy laminates. The plug in unit shall be screwed to the basic socket in the module bin with long through bolts and knurled heads.

9.4.8 The front plates of the plug in unit shall have the switches, the potentiometers, miniature monitoring meters, test points etc. Each plug in unit shall have its own identification legend.

9.4.9 All plug in units shall be polarized to prevent incorrect insertions into the module bin.

9.4.10 The gap between two plug in units inside a bin shall be sufficient to permit adequate ventilation.

9.4.11 The copper side of the printed circuit board shall be lacquered to prevent oxidation.

9.4.12 Each side of the printed circuit board shall have a shield cover to prevent inter circuit and external interference.

9.4.13 The P.C.B. shall be mounted on P.C.B. guides fixed on standard racks and the shield properly grounded.

9.4.14 Control circuit test points shall be easily accessible for monitoring and maintenance.

9.5 Annunciation

9.5.1 The annunciator shall work on 220 V DC power supply.

.

9.5.2 Each annunciator window shall have two lamps connected in parallel which operate at not more than 75% of their rated voltage.

9.5.3 Window shall be arranged in a logical group.

9.5.4 The annunciator shall have a module construction with glass epoxy plug in cards.

9.5.5 Alarm bell/siren shall be continuously rated and shall have a series resistance.

9.5.6 The annunciator shall have the following facilities.

a) First in sequence, memory reset.
b) Fleeting faults shall be memorised.
c) Test Feature.

9.5.7 There shall be a three tier system of protection and annunciation:

a) Alarm both audible and visual.
b) Warning with delayed shut down –time delay through a timer of range 0-60 sec.
c) Disturbance associated with failures of systems elsewhere.

9.6 Meters

9.6.1 Individual meters shall be provided for speed reference, speed feedback, current reference, current feedback, pulse output, and regulated power supply voltages.

9.6.2 All meters shall be identical and fed through individual buffer I.C. amplifiers.

9.6.3 All meters shall be the circular scale type having a full scale deflection of 2700.

9.6.4 All meters shall conform to at least accuracy class 1.0.

9.6.5 All meters with their individual buffer amplifier cards shall be housed in separate bin. It is recommended that the buffer amplifiers all be housed on a single/two card/s and this card/s be itself/themselves housed in the regulator bin. Sensitive signal leads in that case will not have to traverse from one bin to another, only noise insensitive buffer amplifier output leads will need to go to the meter bin.

9.6.6 Selector switches if used with any meters shall have pistol grip handles.

9.7 Wiring

9.7.1 Stranded, flexible copper cables of 2.5 sq.mm shall be used for C.T. circuits and 1.5 sq.mm for other control circuits. However for PCB terminals 0.75 sq.mm may be accepted.

9.7.2 Ultra flexible cables shall be used for all connections from a fixed part to a movable member. In addition, a hanging loop of sufficient length shall be provided to avoid any cable stressing.

9.7.3 All terminal boards for outgoing connections shall be at a height of at least 250 mm from the cubicle floor, and preferably tilted at an angle of 450 to the horizontal for ease of connections. Similarly, connection of the incoming power cables to the bus bars shall be done at a height of at least 250 mm from the cubicle floor.

9.7.4 Item designation and location marking shall be in line with IEC recommendations.

9.7.5 Device labeling shall be on its fixed mounting and not on the device itself such that labeling remains even when the device is replaced. Metallic labels/paper labels or sticker shall be accepted.

10.0 HARMONICS LIMITATIONS

The harmonics generated on source (Input) side (Both AC/DC drive) and output side (For AC drive only) shall be restricted to the following limits: (IEEE-519 for source side and IEC-61800 for load side)

a) Voltage Harmonics Source side Load side Maximum 5% Maximum 5%(THD)
b) Current Harmonics Source side
    i. 5th Maximum 30%
    ii. 7th Maximum 20%
    iii. 11th Maximum 10%

Bidder shall indicate clearly the method of achieving above requirement.

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For AC Drives

Sr.no	Particulars	Rating
1	Type of frequency converter	Voltage Source Inverter/ Current SourceInverter
2	Type of application	Conveyors, pumps, compressors, fans etc.
3	Type of converter cooling	Natural air/ forced cooled
4	Rated Input Voltage a. up to 160 kW b. above 160 up to 1500 kW c. above 1500 kW	415 V 3.3 kV 11 kV
5	Rated Output Voltage	0-100% of supply Voltage
6	Type of motor	Squirrel cage Induction Motors
7	Type of Inverter	Voltage Source Inverter/ Current SourceInverter with constant torque/constanthorsepower operation as required by the application.

SECTION-I

SUB SECTION C6

ANNEXURE-I

LIST OF MAKES OF SUB-VENDOR ITEMS

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 85/19 dt 4.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
1	SCREW CHILLER	YORK*	YES	I	Approved	INSPECTION AS PER APPROVED QAP *FOREIGN SUPPLIER: NO WITNESSING SHALL BE CARRIED OUT. MATERIAL SHALL BE CLEARED BASED ON TC.
		TRANE*	YES		Approved	
		CARRIER	YES		Approved	
		KIRLOSKAR	YES		Approved	
		DUNHAM BUSH*	YES		Approved	
		MCQUAY (DAIKIN)	YES		Approved	
		BLUE STAR	YES		Approved	
		VOLTAS	YES		Approved	
2	PRECISION PACKAGE UNITS	STULZ	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		UNIFLAIR	YES		Approved	
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	YES		Approved	
		BLUEBOX	YES		Approved	
		CLIMADENTA	YES		Approved	
3	PACKAGE UNIT	VOLTAS	YES	III	Approved	INSPECTION AS PER APPROVED QAP
		BLUE STAR	YES		Approved	
		CARRIER	YES		Approved	
4	SPLIT / CASSETTE AIR CONDITIONER	VOLTAS	YES	III	Approved	MATERIAL WILL BE CLEARAED BASED ON MANUFACTURER TC
		BLUE STAR	YES		Approved	
		CARRIER	YES		Approved	
		HITACHI-HIREL	YES		Approved	
		LG	YES		Approved	
5	AIR HANDLING UNITS	VOLTAS	YES	II	Approved	INSPECTION AS PER APPROVED QAP
		BLUE STAR	YES		Approved	
		ZECO	YES		Approved	
		CARRYAIRE (FLAKT)	YES		Approved	
		EDGETECH	YES		Approved	
		ETHOS	YES		Approved	
		SYSTEM AIR	YES		Approved	
		ROOTS COOLING SYSTEM (RCS)	**AIR CONDITIONING SYSTEM SUPPLIER NAME ADDED.**		Approved	
		WAVES AIRCON	YES		Approved	
6	FAN COIL UNITS	VOLTAS	YES	III	Approved	INSPECTION AS PER APPROVED QAP
		BLUE STAR	YES		Approved	
		ZECO	YES		Approved	
		CARRYAIRE (FLAKT)	YES		Approved	
		EDGETECH	YES		Approved	
		ETHOS	YES		Approved	
		SYSTEM AIR	YES		Approved	
		WAVES AIRCON	YES		Approved	
7	AHU FAN (CENTRIFUGAL FAN)	CB DOCTOR	YES	II	Approved	INSPECTION AS PER APPROVED QAP *FOREIGN SUPPLIER: NO WITNESSING SHALL BE CARRIED OUT. MATERIAL SHALL BE CLEARED BASED ON TC.
		FLAKT	YES		Approved	
		KRUGER*	YES		Approved	
		NICOTRA*	YES		Approved	
		COMEFRI	YES		Approved	
		MARATHON	YES		Approved	
		PATEL AIR	YES		Approved	
		ADVANCE	YES		Approved	
		DRAFT AIR	YES		Approved	
		HYDERABAD POLLUTION	YES		Approved	
		SK SYSTEM	YES		Approved	
		SARLA	YES		Approved	
		BEST & CROMPTON	YES		Approved	
		JYOTI	YES		Approved	
		SAM TURBO	YES		Approved	
		KBL	YES		Approved	
		KSB	YES		Approved	
		M&P	YES		Approved	
		VOLTAS	YES		Approved	

2x660 MW ENNORE SEZ STPP						
Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited						
This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 859 /19 dt 6.02.19						
SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)						
SL. NO	**ITEM**	**SUB-VENDOR**	**MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM**	**INSPECTION CATEGORY approved by TANGEDCO**	**TANGEDCO approval for Ennore SEZ**	**BHEL REMARKS**
8	PUMPS	BEACON-WEIR	YES	III	Approved	INSPECTION AS PER APPROVED QAP
		WORTHINGTON	YES		Approved	
		FLOWMORE	YES		Approved	
		SULZER PUMPS INDIA LTD.	YES		Approved	
		BHARAT PUMPS & COMPRESSORS LTD	YES		Approved	
		FLOWSERVE INDIA CONTROL PVT LTD	YES		Approved	
		V-FLOW PUMPS & SYSTEMS CO	YES		Approved	
		KISHORE PUMPS	YES		Approved	
9	COOLING TOWER	PAHARPUR	YES	III	Approved	INSPECTION AS PER APPROVED QAP
		MIHIR	YES		Approved	
		PCT	YES		Approved	
		FLOWTECH	YES		Approved	
		BELL	YES		Approved	
10A	LV MOTORS (NON FLAME PROOF)	SIEMENS	YES	II / III	Approved	INSPECTION AS PER APPROVED QAP CAT - II FOR MOTOR > 30 KW CAT - III FOR MOTOR <= 30 KW
		ABB	YES		Approved	
		CGL	YES		Approved	
		MARATHON	YES		Approved	
		KEC	YES		Approved	
		BHARAT BIJLEE	YES		Approved	
		NGEF	YES		Approved	
		JYOTI	YES		Approved	
		LHP	YES		Approved	
		BHARAT ELECTRIC	YES		Approved	
10B	LV MOTORS (NON FLAME PROOF)	SIEMENS	YES	II / III	Approved	INSPECTION AS PER APPROVED QAP CAT - II FOR MOTOR > 30 KW CAT - III FOR MOTOR <= 30 KW
		ABB	YES		Approved	
		CGL	YES		Approved	
		MARATHON	YES		Approved	
		KEC	YES		Approved	
		BHARAT BIJLEE	YES		Approved	
		NGEF	YES		Approved	
		JYOTI	YES		Approved	
		LHP	YES		Approved	
		BHARAT ELECTRIC	YES		Approved	
11	AIR FILTER	PUROLATOR	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		EMI	YES		Approved	
		ANFILCO	YES		Approved	
		TENACITY	YES		Approved	
		JOHN FOWLER	YES		Approved	
		SPECTRUM	YES		Approved	
		AIR TECH	YES		Approved	
		PUROMATIC	YES		Approved	
12	AXIAL FANS	FLAKT	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		KHAITAN	YES		Approved	
		PATEL AIR	YES		Approved	
		NICOTRA	YES		Approved	
		SARLA (SITAL)	YES		Approved	
		KRUGER	YES		Approved	
		MARATHON	YES		Approved	
		C B DOCTOR	YES		Approved	
		HYDERABAD POLLUTION	YES		Approved	
		SK SYSTEM	YES		Approved	
		ADVANCE	YES		Approved	
13	INSULTATION MATERIAL	BEARDSHEL	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		K-FLEX	YES		Approved	
		PARAMONT	YES		Approved	
		ARMAFLEX	YES		Approved	
		SUPREME	YES		Approved	
		LLOYDS	YES		Approved	
		UP TWIGA	YES		Approved	
		AEROCELL	YES		Approved	
		ADVANCE	YES		Approved	MATERIAL WILL BE CLERAED

2x660 MW ENNORE SEZ STPP						
Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited						
This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 851 /19 dt 6.02.19						
SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)						
SL. NO	**ITEM**	**SUB-VENDOR**	**MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM**	**INSPECTION CATEGORY approved by TANGEDCO**	**TANGEDCO approval for Ennore SEZ**	**BHEL REMARKS**
14	BALANCING VALVE	CASTLE *	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		ATAM VALVE*	YES		Approved	
15	BUTTERFLY VALVES	ADVANCE	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		AUDCO	YES		Approved	
		FOURESS ENGG	YES		Approved	
		INTER VALVE	YES		Approved	
		BDK	YES		Approved	
		WEIR BDK	YES		Approved	
		TYCO	YES		Approved	
		CRANE PROCESS	YES		Approved	
		KEYSTONE	YES		Approved	
		FLUIDLINE	YES		Approved	
		INSTRUMENTATION LTD	YES		Approved	
		R AND D MULTIPLES (METAL CAST) PVT LTD	YES		Approved	
		SURYA VALVES AND INSTRUMENTS MFG CO	YES		Approved	
		PENTAIR VALVES AND CONTROLS INDIA PRIVATE LIMITED	YES		Approved	
		UPADHAYA VALVES MANUFACTURERS PRIVATE LIMITED	YES		Approved	
		VENUS PUMPS AND ENGG. WORKS	YES		Approved	
16	NON RETURN VALVE	LEADER VALVES	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		H SARKAR	YES		Approved	
		FLUIDLINE	YES		Approved	
		HI-TECH	YES		Approved	
		CRESCENT VALVES	YES		Approved	
		A V VALVES	YES		Approved	
		BANKIM	YES		Approved	
		SHIVADURGA	YES		Approved	
		SURYA VALVES AND INSTRUMENT MANUFACTURING	YES		Approved	
		ATAM VALVES	YES		Approved	
		GM DAULI & SONS	YES		Approved	
		KBL	YES		Approved	
		VENUS PUMPS AND ENGINEERING WORKS	YES		Approved	
17	STEEL GATE/GLOBE/NR VALVES(WATER SYSTEM)	CRESCENT VALVES	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		BDK	YES		Approved	
		AUDCO	YES		Approved	
		FOURESS ENGG	YES		Approved	
		KIRLOSKAR BROTHERS LTD.	YES		Approved	
		SANT VALVES	YES		Approved	
		BOMBAY METAL & ALLOYS	YES		Approved	
		BANKIM	YES			
		LEADER VALVES	YES		Approved	
		H SARKAR	YES		Approved	
		AV VALVES	YES		Approved	
		VENUS PUMPS	YES		Approved	
		FLUIDLINE	YES		Approved	
		HI –TECH	YES		Approved	
		SHIVADURGA	YES		Approved	
		SURYA VALVES AND INSTRUMENT MANUFACTURING	YES		Approved	
		ATAM VALVES	YES		Approved	
		GM DAULI & SONS	YES		Approved	
		KBL	YES		Approved	
18	3 / 4 WAY MIXING VALVE WITH	SIEMENS BUILDING TECHNOLOGY	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		JOHNSON	YES		Approved	
		BELIMO	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 857 /19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
	ACTUATING MOTOR	HONEYWELL AUTOMATION	YES		Approved	BASED ON MANUFACTURER TC
		RAPID CONTROL	YES		Approved	
		ALC	YES		Approved	
19	BUTTERFLY VALVE (MOTORIZED)	ANERGY	YES	II	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		ADVANCE	YES		Approved	
		BELIMO	YES		Approved	
		JOHNSON	YES		Approved	
		HONEYWELL AUTOMATION	YES		Approved	
		SIEMENS	YES		Approved	
		LEADER	YES		Approved	
		H.SARKAR	YES		Approved	
		FLUID LINE	YES		Approved	
		A V VALVES	YES		Approved	
		BANKIM & COMPANY	YES		Approved	
		SURYA VALVES AND INSTRUMENT MANUFACTURING	YES		Approved	
		ATAM VALVES	YES		Approved	
		GM DAULI & SONS	YES		Approved	
		KBL	YES		Approved	
		VENUS PUMPS AND ENGINEERING WORKS	YES		Approved	
20	ACTUATOR FOR MOTORIZED BUTTERFLY VALVE	SIEMENS BUILDING TECHNOLOGY	YES	II	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		JOHNSON	YES		Approved	
		BELIMO	YES		Approved	
		HONEYWELL	YES		Approved	
		RAPID CONTROL	YES		Approved	
		ALC	YES		Approved	
		AUMA	YES		Approved	
		ROTORK	YES		Approved	
		WEIR BDK	YES		Approved	
		LIMITORQUE	YES		Approved	
21	Y / POT STRAINER	MULTITEX	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		GREAVES COTTON	YES		Approved	
		JAYPEE	YES		Approved	
		SANT VALVES	YES		Approved	
		OTOKLIN	YES		Approved	
		GRAND PRIX	YES		Approved	
		GUJARAT OTOLIFT	YES		Approved	
		DS ENGG	YES		Approved	
		SAROJINI ENTERPRISE	YES		Approved	
		BHATIA ENGINEERING	YES		Approved	
		FILTERATION ENGINEERS INDIA PVT LTD	YES		Approved	
		SUNGOV ENGINEERING	YES		Approved	
22	PIPES (MS/GI) - ERW	SURYA ROSHNI	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TISCO	YES		Approved	
		DADU PIPES	YES		Approved	
		INDUS TUBES	YES		Approved	
		WELSPUN	YES		Approved	
		TATA	YES		Approved	
		BST	YES		Approved	
		JINDAL	YES		Approved	
		SAIL	YES		Approved	
		PSL	YES		Approved	
		LALIT PROFILE	YES		Approved	
		SAMSHI PIPE INDUSTRIES	YES		Approved	
		S MUKUT PIPES	YES		Approved	
		MANN INDUSTRIES	YES		Approved	
		SURENDRA ENGINEERING	YES		Approved	
		PRATIBHA PIPES AND STRUCTURES PVT LTD	YES		Approved	
		JCO GAS PIPES	YES		Approved	
		NUKAT TANK AND VESSELS	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 83 /19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
		GOODLUCK TUBES	YES		Approved	
		ADVANCE STEEL TUBES	YES		Approved	
		BIHAR TUBES	YES		Approved	
		HITECH PIPES	YES		Approved	
		RATNAMANI	YES		Approved	
		MAHARASHTRA SEAMLESS	YES		Approved	
23	PIPING - CS SEAMLESS (ASTM A 106)	ISMT	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		MAHARASTRA SEAMLESS	YES		Approved	
24	GI SHEETS FOR DUCTING	TISCO	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		INDIAN IRON & STEEL CO	YES		Approved	
		RASHTRIYA ISPAT NIGAM LIMITED	YES		Approved	
		ESSAR	YES		Approved	
		ISPAT INDUSTRIES	YES		Approved	
		JSW	YES		Approved	
		JSPL	YES		Approved	
		UTTAM VALUE	YES		Approved	
		LLOYDS	YES		Approved	
		BHUSHAN STEELS	YES		Approved	
		TATA	YES		Approved	
		SAIL	YES		Approved	
		JINDAL	YES		Approved	
25	FIRE DAMPER	TSC	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		CARRYAIRE	YES		Approved	
		RAVISTAR (SYSTEM AIR)	YES		Approved	
26	GRILL/DIFFUSER/VOLUME CONTROL DAMPER	AIR FLOW	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TSC	YES		Approved	
		AIR MASTER	YES		Approved	
		RCS*	YES		Approved	
		CARRYAIRE	YES		Approved	
		RAVISTAR (SYSTEM AIR)	YES		Approved	
27	STRIP HEATER	ESCORTS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		RACOLDS	YES		Approved	
		DASPASS	YES		Approved	
		ALCO	YES		Approved	
		HEATCO	YES		Approved	
		HOTSET	YES		Approved	
28	PAN HUMIDIFIER	RAPID COOL	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		HOTSET	YES		Approved	
		ALCO	YES		Approved	
29	RELIEF / PURGE VALVE	BRASSOMATIC	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
30	THERMOSTATS	HONEYWELL AUTOMATION	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		RANCO	YES		Approved	
		PENN	YES		Approved	
		DANFOSS	YES		Approved	
		INDFOSS	YES		Approved	
		JHONSON CONTROL	YES		Approved	
		RANUTROL	YES		Approved	
31	HUMID STAT	JHONSON CONTROL	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		HONEYWELL AUTOMATION	YES		Approved	
		PENN	YES		Approved	
32	ANTI FREEZE THERMOSTAT	RANCO	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		HONEYWELL AUTOMATION	YES		Approved	
		PENN	YES		Approved	
		DANFOSS	YES		Approved	
		INDFOSS	YES		Approved	
		GENERAL INSTRUMENT CONSORTIUM	YES		Approved	
		BELLS CONTROLS LTD	YES		Approved	
		H. GURU IND	YES		Approved	
		WAAREE INSTRUMENTS	YES		Approved	
		H. GURU INST	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 89/19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
33	PRESSURE GAUGE/ DIFF.PRESSURE GAUGE	FORBES MARSHALL	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		MANOMETER INDIA	YES		Approved	
		A. N INSTRUMENT	YES		Approved	
		GAUGES BOURDON	YES		Approved	
		GLUCK INDIA	YES		Approved	
		WIKA.	YES		Approved	
		ASHCROFT INDIA PVT LTD.	YES		Approved	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	YES		Approved	
		PRECISION MASS PRODUCTS	YES		Approved	
		BOSE PANDA INSTRUMENTS PVT.LTD.	YES		Approved	
34	TEMPERATURE GAUGE	H. GURU INDUSTRIES	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		H. GURU INSTRUMENT	YES		Approved	
		FORBES MARSHALL	YES		Approved	
		DETRIVE INST & ELECTRONICS	YES		Approved	
		PYRO ELECTRIC	YES		Approved	
		TOSHNIWAL	YES		Approved	
		BROSS	YES		Approved	
		WAREE INSTRUMENTS	YES		Approved	
		A. N INSTRUMENT	YES		Approved	
		GOA INSTRUMENTS	YES		Approved	
		WIKA	YES		Approved	
		ASHCROFT INDIA PVT LTD.	YES		Approved	
		H. GURU IND	YES		Approved	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	YES		Approved	
		GOA THERMOSTATIC	YES		Approved	
		GAUGES BOURDON	YES		Approved	
		BUDENBERG GAUGE	YES		Approved	
		PRECISION MASS PRODUCTS	YES		Approved	
35	LEVEL INDICATOR	GENERAL INSTRUMENT CONSORTIUM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		CHEMTROL	YES		Approved	
		SBEM	YES		Approved	
		AUTOMAT MUMBAI	YES		Approved	
		SIGMA	YES		Approved	
		TOSHNIWAL	YES		Approved	
		TECHNOMATIC	YES		Approved	
		TELACO	YES		Approved	
		LEVCON	YES		Approved	
		D K INSTRUMENTS	YES		Approved	
		PUNE TECHTROL	YES		Approved	
		FLOW STAR	YES		Approved	
		BLISS ANAND	YES		Approved	
36	PRESSURE/ DP/ VACUUM/ TEMPERATURE SWITCH	BELLS CONTROLS LTD	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		DANFOSS	YES		Approved	
		DK INSTRUMENTS	YES		Approved	
		DRESSER	YES		Approved	
		SOR INC	YES		Approved	
		VASU	YES		Approved	
		SWITZER INSTRUMENT LTD.	YES		Approved	
		INDFOSS	YES		Approved	
		TRAFAG	YES		Approved	
		GIC	YES		Approved	
		ASHCROFT INDIA PVT LTD.	YES		Approved	
		KASTURBA UDYOG	YES		Approved	
		BARKSDALE GMBH	YES		Approved	
		PRECISION MASS PRODUCTS	YES		Approved	
		MITTAL REFRIGERATION	YES		Approved	
		INDFOSS	YES		Approved	MATERIAL WILL BE CLERAED
		SIEMENS	YES		Approved	
		DANFOSS	YES		Approved	
		DK INSTRUMENTS	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 857 /19 dt 6 .02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
37	TEMPERATURE SWITCH	SOR INC	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		VASU	YES		Approved	
		DRESSER	YES		Approved	
		TOSHNIWAL	YES		Approved	
		SWITZER INSTRUMENT LTD.	YES		Approved	
38	FLOW SWITCH	SWITZER INSTRUMENT LTD.	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		LEVCON	YES		Approved	
		DK INSTRUMENTS	YES		Approved	
		SBEM	YES		Approved	
		V AUTOMAT	YES		Approved	
		SIEMENS	YES		Approved	
39	LEVEL SWITCH-FLOAT TYPE	SBEM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		BLISS ANAND	YES		Approved	
		HI-TECH	YES		Approved	
		RAMAN INST	YES		Approved	
		SIGMA	YES		Approved	
		SOR INC	YES		Approved	
		WAREE INST	YES		Approved	
		LEVCON	YES		Approved	
		DK INSTRUMENTS	YES		Approved	
		V AUTOMAT	YES		Approved	
		CHEMTROL	YES		Approved	
		SIEMENS	YES		Approved	
		FLOW STAR	YES		Approved	
		TRAC	YES		Approved	
		FLOW TECH	YES		Approved	
		NIVO CONTROLS	YES		Approved	
		PUNE TECHTROL	YES		Approved	
		SAPCON INSTRUMENT	YES		Approved	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	YES		Approved	
		GIC	YES		Approved	
40	LEVEL SWITCH-CAPACITANCE TYPE	SBEM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		BLISS ANAND	YES		Approved	
		HI-TECH	YES		Approved	
		RAMAN INST	YES		Approved	
		SIGMA	YES		Approved	
		SOR INC	YES		Approved	
		WAREE INST	YES		Approved	
		LEVCON	YES		Approved	
		DK INSTRUMENTS	YES		Approved	
		V AUTOMAT	YES		Approved	
		CHEMTROL	YES		Approved	
		SIEMENS	YES		Approved	
		FLOW STAR	YES		Approved	
		TRAC	YES		Approved	
		FLOW TECH	YES		Approved	
		NIVO CONTROLS	YES		Approved	
		PUNE TECHTROL	YES		Approved	
		SAPCON INSTRUMENT	YES		Approved	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	YES		Approved	
		GIC	YES		Approved	
41	FLOW TRANSMITTERS	SBEM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TAYLOR	YES		Approved	
		ABB	YES		Approved	
		BRISTOL BABCOCK	YES		Approved	
		BIRLA KENT TAYLOR	YES		Approved	
		BLISS ANAND	YES		Approved	
		SMART INST	YES		Approved	
		V AUTOMAT	YES		Approved	
		FISHER-ROSEMOUNT	YES		Approved	
		SIEMENS	YES		Approved	
		TATA HONEYWELL	YES		Approved	

2x660 MW ENNORE SEZ STPP						
Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited						
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SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)						
SL. NO	**ITEM**	**SUB-VENDOR**	**MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM**	**INSPECTION CATEGORY approved by TANGEDCO**	**TANGEDCO approval for Ennore SEZ**	**BHEL REMARKS**
		PUNE TECHTROL	YES		Approved	BASED ON MANUFACTURER TC
		NIVO CONTROLS	YES		Approved	
		PANAM ENGINEERS	YES		Approved	
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	YES		Approved	
		MOORE	YES		Approved	
		TOSHNIWAL	YES		Approved	
		YOKOGAWA	YES		Approved	
		E&H	YES		Approved	
		ABB	YES		Approved	
42	PRESSURE/ DIFF. PRESSURE TRANSMITTER	SBEM	YES	II	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TAYLOR	YES		Approved	
		ABB	YES		Approved	
		BRISTOL BABCOCK	YES		Approved	
		BIRLA KENT TAYLOR	YES		Approved	
		BLISS ANAND	YES		Approved	
		SMART INST	YES		Approved	
		V AUTOMAT	YES		Approved	
		FISHER-ROSEMOUNT	YES		Approved	
		SIEMENS	YES		Approved	
		TATA HONEYWELL	YES		Approved	
		PUNE TECHTROL	YES		Approved	
		NIVO CONTROLS	YES		Approved	
		PANAM ENGINEERS	YES		Approved	
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	YES		Approved	
		MOORE	YES		Approved	
		TOSHNIWAL	YES		Approved	
		YOKOGAWA	YES		Approved	
		ENDRESS+HAUSER (INDIA)	YES		Approved	
		FUJI	YES		Approved	
		HONEYWELL AUTOMATION	YES		Approved	
		ABB	YES		Approved	
43	TEMPERATURE TRANSMITTERS	ABB	YES	II	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		ENDRESS+HAUSER (INDIA)	YES		Approved	
		MOORE	YES		Approved	
		SIEMENS	YES		Approved	
		SMART INST	YES		Approved	
		SBEM	YES		Approved	
		TOSHNIWAL	YES		Approved	
		V AUTOMAT	YES		Approved	
		EMERSON PROCESS MANAGEMENT (ROSEMOUNT)	YES		Approved	
		YOKOGAWA	YES		Approved	
		HONEYWELL AUTOMATION	YES		Approved	
44	SIGHT FLOW INDICATORS	SIGMA	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		LEVCON	YES		Approved	
		V AUTOMAT	YES		Approved	
		TELLACE	YES		Approved	
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	YES		Approved	
		TATA HONEYWELL	YES		Approved	
		BLISS ANAND	YES		Approved	
		SCIENTIFIC DEVICES	YES		Approved	
		BK EQUIPMENTS	YES		Approved	
		INSTRUMENTATION ENGINEERS	YES		Approved	
45	FLOW ELEMENT - ORIFICE	BRISTOL BABCOCK	YES	II	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		BALIGA LIGHTING EQPT PVT LTD	YES		Approved	
		LIGHTING EQUIP	YES		Approved	
		ENGINEERING SPECIALITIES	YES		Approved	
		IL	YES		Approved	
		MINCO	YES		Approved	
		MICRO PRECISION	YES		Approved	

2x660 MW ENNORE SEZ STPP						
Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited						
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SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)						
SL. NO	**ITEM**	**SUB-VENDOR**	**MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM**	**INSPECTION CATEGORY approved by TANGEDCO**	**TANGEDCO approval for Ennore SEZ**	**BHEL REMARKS**
		STAR-MECH CONTROLS (I) PVT LTD.	YES		Approved	
46	TEMPERATURE ELEMENT	GENERAL INSTRUMENT CONSORTIUM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		PYRO ELECTRIC	YES		Approved	
		WAAREE INSTRUMENTS	YES		Approved	
		DETRIVE INST & ELECTRONICS	YES		Approved	
		TOSHNIWAL	YES		Approved	
		GOA INSTRUMENTS	YES		Approved	
		GAUGES BOURDON	YES		Approved	
		TECHNO INSTRUMENTS	YES		Approved	
		TEMPSENS INSTRUMENTS	YES		Approved	
		THERMAL INSTRUMENTS	YES		Approved	
		TM TECNOMATIC SPA	YES		Approved	
		BAUMER TECHNOLOGIES INDIA PVT. LTD.	YES		Approved	
47	FLOW METER	EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		INSTRUMENTATION ENGINEERS	YES		Approved	
		PLACKA	YES		Approved	
		TRAC	YES		Approved	
		FLOW STAR	YES		Approved	
		SCIENTIFIC DEVICES	YES		Approved	
48	RH SENSOR/TEMP SENSOR	HONEYWELL AUTOMATION	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		JOHNSON	YES		Approved	
		SIEMENS	YES		Approved	
		GENERAL INSTRUMENT CONSORTIUM	YES		Approved	
49	ANNUNCIATOR	ICC	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		PECON	YES		Approved	
		PROCON	YES		Approved	
50	LT ADAPTER BOX FOR AL TO CU CABLE CONVERTOR	CONTROL DEVICE	YES		Approved	
		SYSTEM POWER CONTROL	YES		Approved	
		JACKSON ENGINNEERS	YES		Approved	
		UNILEC	YES		Approved	
		ELECTRIC ALLIED PRODUCT	YES		Approved	
51	METERING PUMPS	SHAPO TOOLS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		VK PUMPS	YES		Approved	
52	ROTAMETER	CHEMTROLS SAMIL (INDIA) PVT LTD.	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		EUREKA INDUSTRIAL EQUIPMENTS PVT.LTD.	YES		Approved	
		IL	YES		Approved	
		TRANSDUCERS AND CONTROL	YES		Approved	
53	NON CHEMICAL TREATMENT EQUIPMENT	THERMAX	YES	III	Approved	DO NOT MANUFACTURE NCTSP
		SCALEBAN EQUIPMENTS PVT. LTD	YES		Approved	
		SCALE OFF	NO		Approved	VENDOR ADDED LATER
		SCALE GUARD	NO		Approved	VENDOR ADDED LATER
		ION EXCHANGE	YES		Approved	DO NOT MANUFACTURE NCTSP
		DOSI ION	YES		Approved	DO NOT MANUFACTURE NCTSP
54	PUSH BUTTONS	SIEMENS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		L&T	YES		Approved	
		BCH	YES		Approved	
		SCHNEIDER	YES		Approved	
		AJMERA INDUSTRIAL	YES		Approved	
		FLEXPRO ELEC	YES		Approved	
		K.S.INST PVT.LTD	YES		Approved	
		SUCHITRA INDUSTRIES	YES		Approved	
		JACKSON	YES		Approved	
		JOSPER	YES		Approved	
		SHRENIK & COMPANY,	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 857/19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
55	JUNCTION BOX	CHEMIN CONTROLS AND	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		CREATIVE INSTRUMENTS & CONTROLS	YES		Approved	
		INFO CONTROL SYSTEMS INC.,	YES		Approved	
		MANISHA COMPOSITEKS PVT LTD	YES		Approved	
		PRAMMEN INDUSTRIES,	YES		Approved	
		SAJAS ELECTRICALS,	YES		Approved	
		SHIBSHA INSTRUMENTS(INDIA)P.LTD.,	YES		Approved	
56	CHAIN PULLEY BLOCK	TUOBRO FURGUSON (INDIA) PVT LTD	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TRACTEL TIRFOR INDIA PVT. LTD.	YES		Approved	
		HERCULES HOISTS LTD.	YES		Approved	
57	ELECTRIC HOIST	CONSOLIDATED HOISTS PVT LTD	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		TUOBRO FURGUSON (INDIA) PVT LTD	YES		Approved	
		EDDY CRANES PVT. LTD.	YES		Approved	
		ARMSEL MHE PVT LTD	YES		Approved	
		ALPHA SERVICES	YES		Approved	
		CENTURY CRANE ENGINEERS PVT LTD	YES		Approved	
		GRIP ENGINEERS PVT LTD	YES		Approved	
		HERCULES HOISTS LTD.	YES		Approved	
		LIFTING EQUIPMENTS AND ACCESSORIES	YES		Approved	
		MANGLA HOISTS PVT LTD	YES		Approved	
		REVA INDUSTRIES LTD.	YES		Approved	
		TECHNO INDUSTRIES	YES		Approved	
58	PAINT	ASIAN PAINTS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		BERGER	YES		Approved	
		GOODLASS NEROLAC	YES		Approved	
		JENSON & NICHOLSON	YES		Approved	
		CDC CARBOLINE	YES		Approved	
		SHALIMAR	YES		Approved	
		ADDISION PAINT LTD	YES		Approved	
		GRAND POLYCOAT	YES		Approved	
		BOMBAY PAINT	YES		Approved	
		HEMPEL PAINT (SINGAPORE)	YES		Approved	
		JOTUN PAINT	YES		Approved	
59	EXPANSION TANK / MAKE-UP WATER TANK	RCS / RCS APPROVED MAKE	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
60	FLOAT VALVE	H.SARKAR	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		LEADER	YES		Approved	
		GM DAULI & SONS	YES		Approved	
61	GM VALVES	LEADER	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		A.V VALVES	YES		Approved	
		ATAM VALVES	YES		Approved	
		VALTECH INDUSTRY	YES		Approved	
		SANT VALVES	YES		Approved	
62	LOCAL CONTROL PANELS	INDUSTRIAL CONTROL & APPLIANCE	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		PYROTECH ELECTRONICS PVT. LTD.	YES		Approved	
		POSITRONICS PVT. LTD.	YES		Approved	
		CONTROL & SWITCHGEAR	YES		Approved	
		SIEMENS	YES		Approved	
		L&T	YES		Approved	
		GE POWER	YES		Approved	
		RITTAL	YES		Approved	
		HOFFMAN	YES		Approved	
63	SOLENOID VALVE	ASCO	YES	III	Approved	MATERIAL WILL BE CLERAED
		ROTEX	YES		Approved	
		SCHRADER	YES		Approved	
		AVCON	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 89/19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
		HERION-NORGREN	YES		Approved	BASED ON MANUFACTURER TC
		IMI-NORGREN	YES		Approved	
		NUCON	YES		Approved	
		JAFFERSON	YES		Approved	
64	INSTRUMENT FITTINGS	PRECISION ENGINEERING INDUSTRIES	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		PANAM ENGINEERS	YES		Approved	
		PERFECT INSTRUMENTATION CONTROL (INDIA) PVT. LTD.	YES		Approved	
		COMFIT & VALVE PVT. LTD.	YES		Approved	
		AURA INCORPORATED	YES		Approved	
		ARYA CRAFTS & ENGINEERING PVT. LTD.	YES		Approved	
		FLUIDFIT ENGINEERS PVT. LTD.	YES		Approved	
		HP VALVES & FITTINGS INDIA PVT. LTD.	YES		Approved	
		FLUID CONTROLS PVT. LTD.	YES		Approved	
		VIKAS INDUSTRIAL PRODUCTS	YES		Approved	
65	INSTRUMENTS P PE / TUBE FITTINGS	VIKAS INDUSTRIAL PRODUCTS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		FLUID CONTROLS PVT. LTD.	YES		Approved	
		AURA INCORPORATED	YES		Approved	
		PRECISION ENGINEERING INDUSTRIES	YES		Approved	
66	AIR FILTER REGULATOR	PLACKA INSTRUMENT	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		SHAVO NORGEN	YES		Approved	
		FISHER SANMAR	YES		Approved	
67	CABLE LUGS (NON FLAME PROOF)	3D	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		DOWELL	YES		Approved	
		CHITRA	YES		Approved	
68	CABLE GLANDS (NON FLAME PROOF)	ARUP	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		SUNIL	YES		Approved	
		QPIE	YES		Approved	
		COMMET	YES		Approved	
69	CONTROL / POWER CABLE	CORDS CABLE	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		RADIANT CABLES	YES		Approved	
		POLYCAB	YES		Approved	
		KEI	YES		Approved	
		NICCO	YES		Approved	
		RAVIN CABLES	YES		Approved	
		INCAB	YES		Approved	
		HVPL	YES		Approved	
		TORRENT CABLE	YES		Approved	
		HAVELLS	YES		Approved	
		PARAMOUNT	YES		Approved	
		SRI RAM CABLES	YES		Approved	
		THERMOCABLES	YES		Approved	
		TORRENT CABLE	YES		Approved	
		UNIVERSAL CABLES	YES		Approved	
		GEMSCAB	YES		Approved	
		DELTON	YES		Approved	
70	CABLE TRAY SUPPORT SYSTEM -BOLTABLE	AM-TECH ENGG.SERVICES	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		INDUSTRIAL PERFORATION (I) PVT.LTD.	YES		Approved	
		INDMARK FORMTECH PVT. LTD.	YES		Approved	
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	YES		Approved	
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	YES		Approved	
		STEELITE ENGINEERING LTD.	YES		Approved	
		ASSOCIATED POWER STRUCTURES PVT. LTD.	YES		Approved	
		INDUSTRIAL PERFORATION (I) PVT.LTD.	YES		Approved	
		INDMARK FORMTECH PVT. LTD.	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

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SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
71	CABLE TRAY SUPPORT SYSTEM-WELDED(GALV)	JAMNA METAL COMPANY	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		PREMIER POWER PRODUCTS (CAL) PVT. LTD.	YES		Approved	
		PATNY SYSTEMS (P) LTD	YES		Approved	
		PASSIVE INFRA PROJECTS PVT. LTD.	YES		Approved	
		RUKMANI ELECTRICAL & COMPONENTS PVT LTD	YES		Approved	
		RATAN PROJECTS & ENGINEERING CO. PVT.LTD.	YES		Approved	
		RABI ENGINEERING WORKS PVT. LTD.	YES		Approved	
		SARAL INDUSTRIES	YES		Approved	
		UNITECH FABRICATORS AND ENGINEERS PVT LTD	YES		Approved	
72	CABLE TRAY SUPPORT SYSTEM-WELDED(UNGALV)	RASHTRIYA ISPAT NIGAM LIMITED	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		STEEL AUTHORITY OF INDIA LTD.	YES		Approved	
73	CABLE TERM.& JOINT KITS	3M ELECTRO AND COMMUNICATION INDIA P.LTD	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		HARI CONSOLIDATED PVT.LTD.,NEW DELHI	YES		Approved	
		RAYCHEM RPG PRIVATE LIMITED	YES		Approved	
		YAMUNA CABLE ACCESSORIES PVT. LTD.	YES		Approved	
74	LIMIT SWITCH	BCH	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		SIEMENS	YES		Approved	
		JAIBALAJI	YES		Approved	
75	ANNUNCIATOR	IIC	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		MINILEC	YES		Approved	
		PROCON	YES		Approved	
76	INTERPOSING RELAY	ABB	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		SIEMENS	YES		Approved	
		ALSTOM	YES		Approved	
		HONEYWELL	YES		Approved	
		OMRONAN	YES		Approved	
		JYOTI	YES		Approved	
77	SELECTOR SWITCH	ALSTOM	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		SIEMENS	YES		Approved	
		L&T	YES		Approved	
		KAYCEE	YES		Approved	
78	INDICATION LAMPS	SIEMENS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		ABB	YES		Approved	
		ALSTOM	YES		Approved	
		TECHNIC	YES		Approved	
		STS	YES		Approved	
		L&T	YES		Approved	
79	PUSHBUTTON	SCHENIDER	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		GE- POWER	YES		Approved	
		ABB	YES		Approved	
		SIEMENS	YES		Approved	
		BCH	YES		Approved	
		ALSTOM	YES		Approved	
		TECHNIC	YES		Approved	
		L&T	YES		Approved	
80	AUX. CONTACTOR	SCHENIDER	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		GE- POWER	YES		Approved	
		ABB	YES		Approved	
		ALSTOM	YES		Approved	
		SIEMENS	YES		Approved	
		L&T	YES		Approved	
81	AUX. RELAYS	SCHENIDER	YES	III	Approved	MATERIAL WILL BE CLERAED
		ASEA BROWN BOVERI LIMITED	YES		Approved	
		ALSTOM	YES		Approved	

2x660 MW ENNORE SEZ STPP

Sub vendor Items and Inspection Category approval to BHEL/PEM for Air Conditioning System - Vendor Name - M/s Roots Cooling System Private Limited

This is Annexure to Lr.No.CE/P I /SE/E/T & H (P)/EE6/E/P/AEE/M/F/Ennore SEZ STPP/D 89/19 dt 6.02.19

SUB VENDOR LIST AND INSPECTION CATEGORY (Document No: PE-V0-412-158-A001-R00)

SL. NO	ITEM	SUB-VENDOR	MAKE APPROVED IN NORTH CHENNAI TPS - AC SYSTEM	INSPECTION CATEGORY approved by TANGEDCO	TANGEDCO approval for Ennore SEZ	BHEL REMARKS
		SIEMENS	YES		Approved	BASED ON MANUFACTURER TC
		ABB	YES		Approved	
		GE- POWER	YES		Approved	
82	TIMER	L&T	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		ABB	YES		Approved	
		HAVELLS	YES		Approved	
		GE-POWER	YES		Approved	
		SIEMENS	YES		Approved	
83	VVVF DRIVE	YASKAWA(L&T)	YES	II	Approved	
		ABB	YES		Approved	
		SIEMENS	YES		Approved	
		DANFOOS	YES		Approved	
		TOSHIBA INDIA	YES		Approved	
		ALLEN BRADELY	YES		Approved	
		HI-REL ELECTRONICS LTD	YES		Approved	
		HITACHI	YES		Approved	
		FUJI	YES		Approved	
		SCHNIEDER	YES		Approved	
84	TRANSFORMERS	INDCOIL	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		LOGICSTAT	YES		Approved	
		KAPPA	YES		Approved	
		AUTOMATIC ELECTRIC	YES		Approved	
		PRECISE ELECTRICALS	YES		Approved	
		SILKAAN ELECTRIC MFG. CO. LTD.	YES		Approved	
		SOUTHERN ELECTRIC	YES		Approved	
		NEC	YES		Approved	
85	MCB	MDS	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		INDO COPP	YES		Approved	
		STANDARD	YES		Approved	
		SIEMENS	YES		Approved	
		L&T	YES		Approved	
		ABB	YES		Approved	
		SCHNEIDER	YES		Approved	
86	COPPER PIPE*	MANDEV	YES	III	Approved	MATERIAL WILL BE CLERAED BASED ON MANUFACTURER TC
		RAJCO	YES		Approved	
		TOTALINE/EQUIVALENT	YES		Approved	

Note:

Category I – Quality Plan approval & Physical Inspection by TANGEDCO as agreed in the Quality Plan are envisaged. Based on Inspection/Inspection Test Report approval. TANGEDCO will issue MDCC.

Category II – Quality Plan approval & Physical Inspection by BHEL as agreed in the Quality Plan are envisaged. Test Reports to be submitted by BHEL & got it approved by TANGEDCO before the issuance of MDCC by TANGEDCO.

Category III - Quality Plan approval & Physical Inspection by TANGEDCO are not envisaged. MDCC to be obtained from TANGEDCO Based on submission of Certificate of Compliance (COC) by BHEL.

CHIEF ENGINEER/PROJECTS I

SECTION-I
SUB SECTION –C6

ANNEXURE-II

MANDATORY SPARE LIST

(REFER SUGGESTIVE PRICE FORMAT)

SECTION-I

SUB-SECTION-C6

ANNEXURE-III

LIST OF TOOLS & TACKLES
AND
LIST OF COMMISSIONING SPARES

(REFER SUGGESTIVE PRICE FORMAT)

SECTION-I

SUB-SECTION-C6

ANNEXURE-IV

DRAWINGS / DOCUMENTS SUBMISSION PROCEDURE

ANNEXURE-I

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD-ROMs (sets)
1.	PLANT DEFINITION MANUAL-	-	3 CD-ROMs
2.	Drawings "FOR APPROVAL"	10	Soft Copy
3.	Drawings "FOR INFORMATION"	10	Soft Copy
4.	Drawings "FINAL APPROVED DRAWING"	8	Soft Copy
5.	Drawings "AS BUILT "	8	3 CD-ROMs
6	DATASHEETS,DESIGNCALCULATIONS,PURCHASE SPECIFICATIONS, etc. and Other type of documents		
	i) For Approval	10	SOFT COPY
	ii) FINAL	8	3 CD-ROMs -
	iii) Analysis reports of equipment/ piping/ structures components/ systems employing software packages as detailed		
	in the specifications		
	a) Input	10	SOFT COPY
	b) Output	10	SOFT COPY
	c) Drawings/ Sketches	10	SOFT COPY
7	Erection manual "FINAL"	8	3CD ROMS
8	Operation & Maintenance manual	10	3CD ROMS
9	Plant Hand Book "DRAFT"	6	SOFT COPY
10	Plant Hand Book "FINAL"	15	3CD ROMS
11	Commissioning and Performance Procedure manual	10	3CD ROMS
12	Performance and Functional Guarantees test report	6	3CD ROMS
13	Progress Reports	6	3CD ROMS
14	Project completion report	10	3CD ROMS
15	QA programme including	1	

S. NO.	DESCRIPTION OF MANUALS	NO OF PRINTS (sets)	NO. OF CD-ROMs (sets)
	Organization for implementation and QA system manual (with revision-servicing)		
16	Vendor details in respect of proposed vendors including Bidder's evaluation report.	1	
17	Manufacturing QPs, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.		
	(i) For review/comment	3	
	(ii) For final approval	4	1 set CD ROMS
18	Welding Manual, Heat Treatment Manuals,	4	
	Storage & preservation manuals		
	Final	4	2 CD ROMS
19	Monthly Vendor Approval	2	1 CD ROM
	and QP approval status		
20	QA Documentation Package for items / equipment manufactured and dispatched to site	2	2 CD ROMS
21	QA Documentation Package for field activities on equipment/systems at site	2	2 CD ROMS

SECTION-II

ANNEXURE-I

FORMAT FOR OPERATION AND MAINTENANCE MANUAL

Project name :
Project number :
Package Name :
PO reference :
Document number :
Revision number :

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
1.	**COVER PAGE**				
1.1	Project Name				
1.2	Customer/consultant Name				
1.3	Name of Package				
1.4	Supplier details with phone, FAX ,email address , Emergency Contact number				
1.5	Name and sign of prepared by , checked by & approved by				
1.6	Revision history with approval Details				
2.0	**INDEX**				
2.1	showing the sections & related page nos All the pages should be numbered section wise				
3.0	**DESCRIPTION OF PLANT/SYSTEM**				
3.1	Description /write up of operating principle of system equipment/ associated sub-systems & accessories/controls system , operating conditions, performance parameters under normal , start up and special cases				
3.2	Equipment list and basic parameter with Tag numbers				
3.3	Data sheets approved by Customer/for information and catalogues provided by original manufacturer				
3.4	Associated other packages and Interface /terminal points				
3.5	P&ID & Process Diagrams				
3.6	GA Layout drawings, As-built drawings , Actual photograph of items/system (Drawings of A2 & bigger sizes are to be attached in the last)				
3.7	Single line/wiring diagrams				
3.8	Control philosophy /control write-ups				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
4.0	**COMMISSIONING ACTIVITIES (IF NOT COVERED IN SEPARATE DOCUMENT I.E. ERECTION MANUAL, COMMISSIONING MANUAL)**				
4.1	Pre-Commissioning Checks				
4.2	handling of items at site				
4.3	Storage at site				
4.4	Unpacking & Installation procedure				
5.0	**OPERATION GUIDELINES FOR PLANT PERSONAL/USER/OPERATOR**				
5. 1	Interlock & Protection logic along with the limiting values of protection settings for the equipment along with brief philosophy behind the logic, drawings etc. to be provided.				
5. 2	Start up, normal operation and shut down procedure for equipments along with the associated systems in step by step mode. Valve sequence chart, step list, interlocks etc. with Equipment isolating procedures to be mentioned.				
5. 3	Do's & Don't of the equipments.				
5. 4	Safety precautions to be taken during normal operation. Safety symbols, Emergency instructions on total power failure condition/lubrication failure/any other condition				
5. 5	Parameters to be monitored with normal values and limiting values				
5. 6	Trouble shooting with causes and remedial measures				
5. 7	Routine operational checks, recommended logs & records				
5. 8	Changeover schedule if more than one auxiliary for the same purpose is given				
5. 9	Painting requirement and schedule				
5. 10	Inspection, repair , Testing and calibration procedures				
6.0	**MAINTENANCE GUIDELINES FOR PLANT PERSONAL**				

Sl.no. & Sections	Description	Tick (√)if included in Manual			Remarks
		Yes	No	Not Applicable	
6.1	List of Special Tools and Tackles required for Overhaul/Trouble shooting including special testing equipment required for calibration etc.				
6.2	Stepwise dismantling and re-assembly procedure clearly specifying the tools to be used, checks to be made, records to be maintained, clearances etc. to be mentioned. Tolerances for fitment of various components to be given.				
6.3	Preventive Maintenance & Overhauling schedules linked with running hours/calendar period along with checks to be given				
6.4	Long term maintenance schedules especially for structural, foundations etc.				
6.5	Consumable list along with the estimated quantity required during commissioning, normal running and during maintenance like Preventive Maintenances and Overhaul. Storage/handling requirement of consumables/self-life.				
6.6	List of lubricants with their Indian equivalent, Lubrication Schedule, Quantity required for each equipment for complete replacement is to be given				
6.7	List of vendors & Sub-vendors with their latest addresses, service centres ,Telephone Nos., Fax Nos., Mobile Nos., e-mail IDs etc.				
6.8	List of mandatory and recommended spare parts list				
6.9	Tentative Lead time required for ordering of spares from the equipment supplier				
6.10	Guarantee and warranty clauses				
7.0	**Statutory and other specific requirements considerations.**				
8.0	**List of reference documents**				
9.0	**Binding as per requirement**				

SECTION-II

ANNEXURE-II

SITE STORAGE AND PRESERVATION

SITE STORAGE AND PRESERVATION GUIDELINES

FOR

MECHNANICAL BOPs

(Doc No: PE-DC-SSG-A001 REV.00)

PROJECT ENGINEERING MANAGEMENT, POWER SECTOR

BHARAT HEAVY ELECTRICALS LIMITED-NOIDA

CONTENT

1. SCOPE OF THE DOCUMENT

This guideline is prepared in intent to provide proper site storage and preservation of the Mechanical, Electrical and C & I items / equipment supplied under various bought out packages/items. This storage procedure shall be followed at different power plant sites by concerned agency for storage and preservation from the date of equipment received at site until the same are erected and handed over to the customer.

2. PURPOSE OF STORAGE & PRESERVATION

Many of the items may be required to be kept in stores for long period. It shall therefore be essential that proper methods of storage and preservation be applied so that items do not deteriorate, loose some of their properties and become unusable due to atmospheric conditions and biological elements.

3. MEASURES TO BE TAKEN FOR STORAGE, HANDLING & PRESERVATION

a) GENERAL STORAGE REQUIREMENTS

1. To the extent feasible, materials should be stored near the point of erection. The storage areas should have adequate unloading and handling facilities with adequate passage space for movement of material handling equipment such as cranes, fork lift trucks, etc. The storage of materials shall be properly planned to minimise time loss during retrieval of items required for erection.
2. The outdoor storage areas as well as semi-closed stores shall be provided with adequate drainage facilities to prevent water logging. Adequacy of these facilities shall be checked prior to monsoon.
3. The storage sheds shall be built in conformity with fire safety requirements. The stores shall be provided with adequate lights and fire extinguishers. ‘No smoking’ signs shall be placed at strategic locations. Safety precautions shall be strictly enforced.
4. Adequate lighting facility shall be provided in storage areas and storage sheds and security personnel positioned to ensure enforcement of security measures to prevent theft and loss of materials.
5. Adequate number of competent stores personnel and security staff shall be deployed to efficiently store and maintain the equipment / material.
7. The equipment shall be stored in an orderly manner, preserving their identification slips, tags and instruction booklets, etc., required during erection. The storage of materials shall be equipment-wise. Loose parts shall be stored in sheds on racks,

preserving the identification marks and tags in good condition. The group codes shall be displayed on the racks

6. At no time shall any materials be stored directly on ground. All materials shall be stored minimum 200 mm above the ground preferably on wooden sleepers

b) GENERAL PRESERVATION REQUIREMENTS

1. All special measures to prevent corrosion shall be taken like keeping material in dry condition, avoiding the equipment coming in contact with corrosive fluid like water, acid etc.
2. Materials which carry protective coating shall not be wrapped in paper, cloth, etc., as these are liable to absorb and retain moisture. The material shall be inspected and in case of signs of wear or damages to protective coating, that portion shall be cleaned with approved solution and coated with an approved protective paint. Complete record of all such observations and protective measures taken shall be maintained.
3. Generally equipment supplied at site are properly greased or rust protective oil is applied on machined/ fabricated components. However periodic inspection shall be carried out to ensure that protection offered is intact.
4. While handling the equipment, no dragging on the ground is permitted. Avoid using wire rope for lifting coated components. Use polyester slings (if possible) otherwise protective material (e.g. clothes, wood block etc.) should be used while handling the components with rope / slings
5. For Equipment supplied with finished paint, touch paint shall be done in case any surface paint gets peeled off during handling. Otherwise such surfaces shall necessarily be wrapped with polythene to avoid any corrosion. Further for equipment wherein finish coat is to be applied at site, site to ensure that equipment is received with primer coat applied.
6. It shall be ensured by periodic inspection that plastic inserts are intact in tapped holes, wherever applicable.
7. Pipes shall be blown with air periodically and it shall be ensured that there is no obstruction.
8. Silica gel or approved equivalent moisture absorbing material in small cotton bags shall be placed and tied at various points on the equipment, wherever necessary.
9. Heavy rotating parts in assembled conditions shall be periodically rotated to prevent corrosion/jamming due to prolonged storage.

10. All the electrical equipment such as motors, generators, etc. shall be tested for insulation resistance at least once in three months and a record of such measured insulation values shall be maintained.

11. Following preservatives/preservation methods can be used depending upon type of equipment

    a. Rust preventive fluid (RPF)

    b. Rust protective paints

    c. Tarpaulin covers, in case of outdoor storage

    d. De-oxy aluminate for weld-ments

c) GENERAL INSPECTION REQUIREMENTS

1. Period inspection of materials with specific reference to –

    - Ingress of moisture and corrosion damages.
    - Damage to protective coating.
    - Open ends in pipes, vessels and equipment -
        - In case any open ends are noticed, same shall be capped.

2. Any damages to equipment / materials.

    - In case of any damages, these shall be promptly notified and in all cases, the repairs / rectification shall be carried out.
    - Any items found damaged or not suitable as per project requirements shall be removed from site. If required to store temporarily, they shall be clearly marked and stored separately to prevent any inadvertent use.

4. TYPE OF STORAGE FOR VARIOUS EQUIPMENT

The types of storage are broadly classified under the following heads:

i **Closed storage with dry and dust free atmosphere**. (C)

The closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated asbestos sheets / galvanised iron sheets for roofing. Brick walls / asbestos sheets can be used to cover all the sides. The floor of the shed can be finished with plain cement concrete suitably glazed. The shed shall be provided with proper ventilation and illumination.

ii **Semi-closed storage**. (S)

The semi closed shed can be constructed by using cold-rolled / tubular components for structure and corrugated / asbestos sheets for roofing. The floor shall be brick paved. If required a small portion of sides can be covered to protect components from rainwater splashing onto the components.

iii Open storage (O)

The open yard shall be levelled, well consolidated to achieve raised ground with the provision of feeder roads for crane approach along with access roads running all sides. One part of the open yard shall be stone pitched, levelled and consolidated with raised ground suitable for storing / stacking heavier and critical components with due space to handle them by cranes etc . Adequate number of sleepers, concrete block etc. to be provided to make raised platforms to stack critical materials.

A separate yard to be identified as “scrap yard” slightly away from main open yard to store wooden/steel scraps, which are to be disposed off. This is required to avoid mix up with regular components as well as to avoid fire hazard.

Some of the components, which are having both machined & un-machined surfaces and are bulky, shall be stored in open storage area on a raised ground and suitably covered with water proof / fire retardant tarpaulin.

The equipment listed below shall be stored and inspected as per requirement mentioned in the table below.

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
Raw material /mechanical items like pipes, plates, structure sections etc.)				
1.	Steel pipes (lined/unlined)	S	Damage , paint, corrosion, rubber lining peeling	Provide end cap
2.	MS Plates	S	Damage, paint, corrosion	
3.	SS Plates	S	Damage	
4.	Non-metallic pipes	S	Damage, cracks	Provide end cap
5.	Stainless steel pipes	S	Damage ,	Provide end cap
6.	MS sections, beams	S	Damage, paint, corrosion	
7.	Cable trays	S	Damage, condition of preservations	
8.	Insulation sheets	S	Damage	
9.	Insulation	C	Damage, packing	
10.	Hangers Rods	S	Damage, paint, packing	
11.	Tubes	S	Damage, paint , packing	Provide end cap
12.	Hume pipes	O	Damage	
13.	Castings	O	Damage, paint, corrosion	
Fabricated mechanical items (pressure vessels, tanks etc.)				
14.	Pressure vessels (unlined)	O	Damage, paint, corrosion,	Covered nozzles
15.	Atmospheric storage tanks (unlined)	O	Damage, paint, corrosion	Covered nozzles

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
16.	Pressure vessels (lined)	S	Damage, paint, corrosion, rubber lining	
17.	Atmospheric storage tanks(lined)	S	Damage, paint, corrosion, rubber lining	
18.	Support structures	O	Damage , paint, corrosion	
19.	Flanges	C	Damage , paint, corrosion	
20.	Fabricated pipes	S	Damage , paint, corrosion	Provide end cap
21.	Vessels internals	C	Damage , paint, corrosion ,packing	
22.	Grills	S	Damage , paint, corrosion	
23.	Angles	S	Damage , paint, corrosion	
24.	Bridge mechanism/clarifier mechanism	O	Damage , paint, corrosion	
25.	Cranes, rails	S	Damage , paint, corrosion	
26.	Stair cases	O	Damage , paint, corrosion	
27.	Ladders/handrails	O	Damage , paint, corrosion	
28.	Fabricated ducts	S	Damage , paint, corrosion	
29.	Isolation Gates	O	Damage , paint, corrosion	
30.	Fabricated boxes/panels	S	Damage , paint, corrosion	
Mechanical components like valves, fittings, cables glands, spares etc.)				
31.	Valves	S	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
32.	Fittings	S	Damage , packing	Provide end cap
33.	Cable glands	C	Damage , packing	
34.	Tools & tackles	C	Damage , packing	
35.	Nut , bolts, washers,	C	Damage , packing	
36.	Gasket & Packings	C	Damage , packing	
37.	Copper tubes	C	Damage , packing, corrosion	Provide end cap
38.	SS tubing	C	Damage , packing	Provide end cap
Rotating assemblies (pumps, blowers, stirrers, fans, compressors etc.)				
39.	Pumps	S	Damage , packing, corrosion	Shaft rotation
40.	Blowers/Compressors	S	Damage , packing, corrosion	Shaft rotation
41.	Agitators/stirrers/radial launders	C	Damage , packing, corrosion	Shaft rotation
42.	Rollers for chlorine tonner mounting	C	Damage , packing, corrosion	
43.	Centrifuge	S	Damage , packing,	
44.	Gear box	C	Damage , packing, corrosion	
45.	Bearings	C	Damage , packing, corrosion	
46.	Fans	S	Damage , packing, corrosion	
47.	Dosing skids	S	Damage , packing, corrosion	
48.	Pump assemblies	S	Damage , packing, corrosion	
49.	Air washers(INTERNALS)	S	Damage , packing	
50.	Air conditioners (split)	C	Damage , packing	

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
51.	Elevators(CONTAINERIZED)	O	Damage , packing, corrosion	
52.	Chillers/VA machines	S	Damage , packing	
53.	Air handling Unit/Package unit	S	Damage , packing	
54.	Chlorinators & Evaporators	C	Damage , packing	
55.	Ejectors	C	Damage , packing	
56.	Electrolyser	C	Damage , packing	
Miscellaneous items like chain pulley blocks, hoists etc.				
57.	Chain pulley blocks	S	Damage, Packing	
58.	Electric hoists	S	Damage, Packing	
59.	Fire extinguishers	C	Damage, expiry date	
60.	Fork Lift Truck	S	Damage, Packing	
61.	Hydraulic Mobile Crane	O	Damage, Packing	
62.	Mobile Pick Up & Carry Crane	O	Damage, Packing	
63.	Motor boats	O	Damage, Packing	
64.	Safety showers	S	Damage, Packing	
65.	Diffusers/dampers	S	Damage, Packing	
Chemicals and consumables (acid, alkali, paints, oils, reagents and special chemicals)				
66.	Hydro Chloric Acid (HCl)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical
67.	Sulphuric acid (H_2SO_4)	Store in canes/ storage tank in dyke area	Date of production/ leakage/fumes	hazardous chemical

Sl. No.	Description of the equipment	Type of Storage	Check for	Remarks
68.	Sodium hydroxide (NaOH)	Store in canes/ storage tank in dyke area	Date of production/ leakage/ fumes/ breather	hazardous chemical ,breather to be checked for air ingress
69.	Sodium hypo chlorite	To be stored under shed	Date of production/ leakage/ fumes	hazardous chemical ,self-life normally 15-30 days after which strength of chemical decays
70.	Ammonia	S	Date of production/ leakage/ fumes	Store in closed storage tanks, hazardous chemical
71.	CW treatment chemicals	S	Date of production , Self-life	Store in closed canes
72.	RO/UF cleaning chemicals	S	Date of production , Self-life	Store in closed canes
73.	Lime	C	Damage to packing , seepage	Prevent moisture, rain
74.	Alum bricks	C	Damage to packing	Prevent moisture, rain
75.	Poly electrolyte	S		Store in closed storage tanks
76.	Laboratory chemicals(powder)	C	Damage, Packing self-life	
77.	Laboratory chemicals(liquid)	C	Damage, Packing self-life	
78.	Lubrication oils	C	Leakage	
79.	Paints	S	Leakage ,air tightness	
80.	Sand	O	Damage of packing	No hooks
81.	Salt (NaCl)	C	Damage of packing, water ingress	Prevent moisture, rain
82.	Anthracite	S	Damage of packing	
83.	Activated carbon	S	Damage of packing	

Sl. No.	**Description of the equipment**	**Type of Storage**	**Check for**	**Remarks**
84.	Thermal insulation	S	Damage of packing	
85.	Cement	C	Damage of packing	Prevent moisture, rain
86.	Gravels	O	Damage of packing	
87.	ION exchange resins	C	Damage , packing	Refer manufacturer guidelines
88.	RO membranes	C	Damage , packing	Refer manufacturer guidelines
89.	UF membranes	C	Damage , packing	Refer manufacturer guidelines
90.	Cleaning chemicals	C	Damage , packing	Refer manufacturer guidelines
91.	Chemicals for analysers/calibration	C	Damage , packing	Refer manufacturer guidelines
Electrical and C & I items (motors, cables etc.)				
92.	Motors	C	Damage , packing	
93.	Cable drums	O	Damage	
94.	Control Panel /control desk, UPS ,JB	S	Damage, Packing	
95.	Instruments(gauges/analysers)	C	Damage	
Special items		As per Manufacturer's item, like Hydrogen cylinders, Ozonator, Analyser, Chlorine dioxide generators etc.		

5. CONCLUSION

Concerned storage agency at site should make sure that loss in equipment performance and wear & tear are minimised through proper storage and preservation. The above are broad guidelines and cover major equipment / materials. However specific storage practices shall be followed as per manufacturer recommendation. All the necessary measures even in addition to the ones mentioned above, if found necessary, should be taken to achieve the objective.

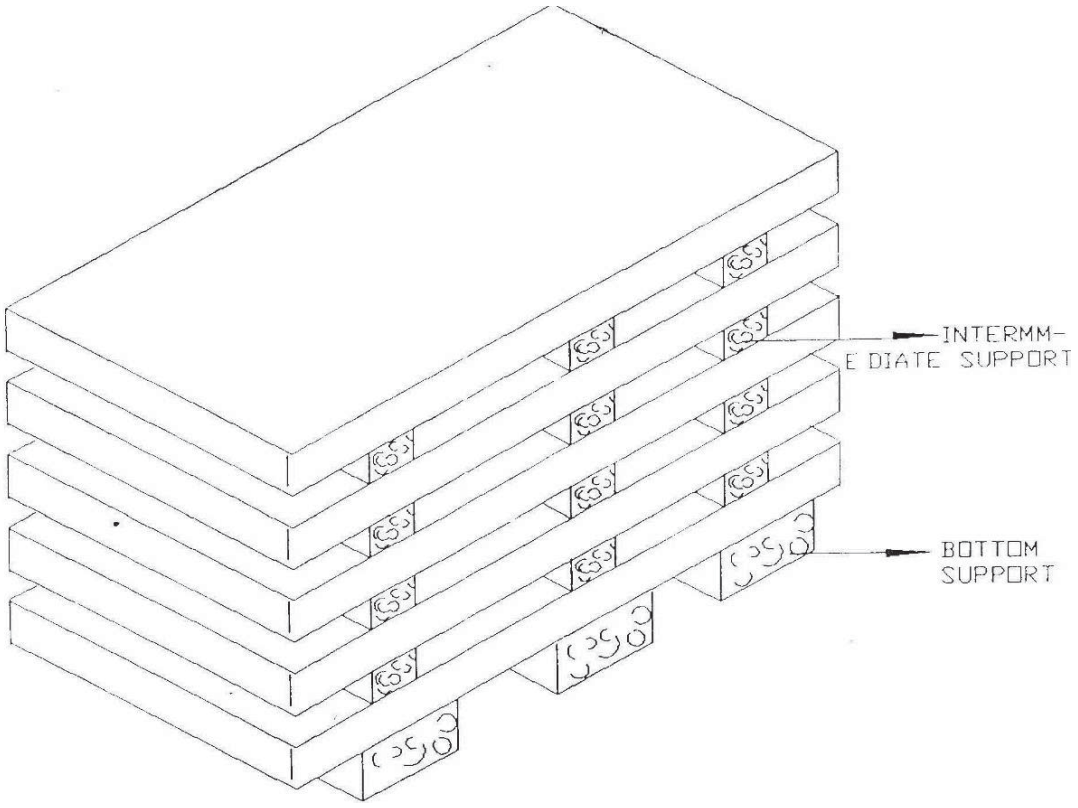

Figure – 1 – PLATE STACKING ARRANGEMENT

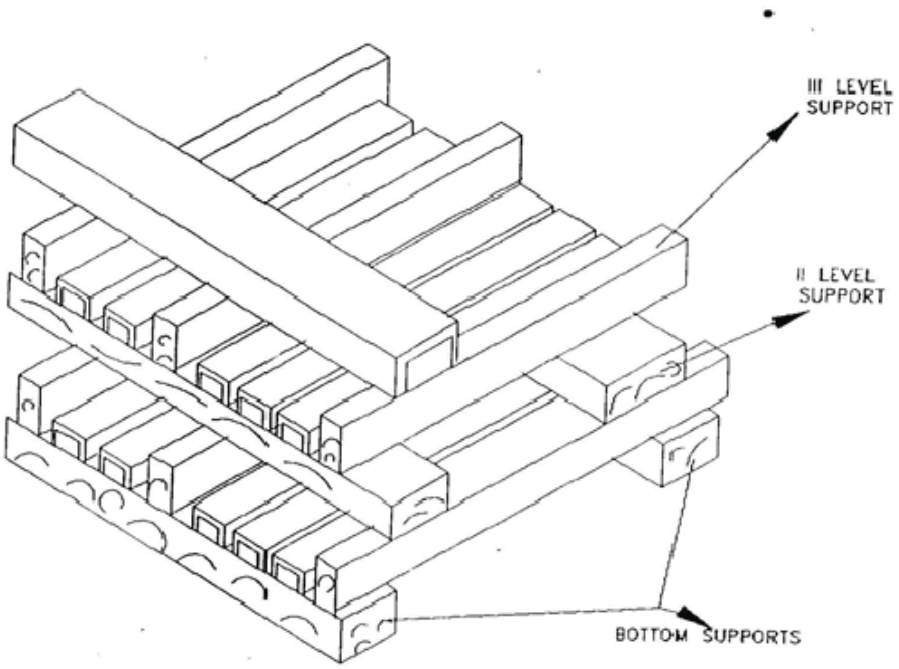

Figure – 2 – STRUCTURAL STEEL STACKING ARRANGEMENT

SECTION-II

ANNEXURE-III

INSPECTION AND TESTING

1.01.00 Inspection and Tests during Manufacture.

1.01.01 The method and techniques to be used by the Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner.

1.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

1.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

1.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The owner's representative shall have at all reasonable times access to bidder's or his sub-vendor's premises and shall have power to inspect/ examine materials and workmanship or equipment under manufacture.

The Bidder shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Further nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere.

For electrical equipment, routine tests as per relevant IS spec are to be carried out on all equipment. Type tests are also to be carried out on selected equipment as detailed in the specs of concerned electrical equipment.

1.01.05 Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.

1.01.06 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.
Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

1.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the

Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material. Equipment or parts coming under any statutory Regulations shall be certified by a Competent Authority under the regulations in the specified format.

1.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.

1.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

1.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major but welding joints shall be radiographed unless otherwise stipulated.

Statutory payments in respect of IBR approvals including inspection shall be made by the bidder. Bidder's scope shall include to preparation of all necessary documents, co-ordination and follow-up for above approval. Owner shall only forward assistance/endorsement of documents /design /drawings /reports/records to be submitted for approval as stipulated/ required by Statutory Authorities till registration of the unit and clearance for commercial operation.

1.02.00 Performance Tests at Site

1.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Bidder on site under normal operating conditions. The Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.

1.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.

1.02.03 The Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.

1.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

LIST OF DOCUMENTS TO BE SUBMITTED WITH BID

BIDDER SHOULD SUBMIT THE SIGNED AND STAMPED COPY OF THE FOLLOWING DOCUMENTS:

1. Compliance cum confirmation certificate
2. No Deviation Certificate mentioning “NIL DEVIATION”
3. Guaranteed Power Consumption (In the format attached in the spec mentioning KW rating).
4. Unpriced copy of the Price format (mentioning quoted against each item)
5. Pre-Bid Clarification / Corrigendum / Amendments

Offer will be considered as incomplete in absence of any of the above documents. Bidder to ensure that all above documents are available in their offer, failing to which bidder offer is liable to be rejected.

Any other document apart from above submitted along with bid will not be taken cognizance off and will not make any part of the contract and accordingly will not be considered for bid evaluation.

COMPLIANCE CUM CONFIRMATION CERTIFICATE

The bidder shall confirm compliance with following by signing / stamping this compliance certificate (every sheet) and furnish same with the offer.

a) The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusions, other than those mentioned under "exclusion and those resolved as per 'Schedule of Deviations', with regard to same.

b) There are no other deviations w.r.t. specifications other than those furnished in the 'Schedule of Deviations'. Any other deviation, stated or implied, taken elsewhere in the offer stands withdrawn unless specifically brought out in the 'Schedule of Deviations'

c) Bidder shall submit QP in the event of order based on the guidelines given in the specification & QP enclosed therein. QP will be subject to BHEL / CUSTOMER approval & customer hold points for inspection / testing shall be marked in the QP at the contract stage. Inspection / testing shall be witnessed as per same apart from review of various test certificates/ Inspection records etc. This is within the contracted price without any extra implications to BHEL after award of the contract.

d) All drawings/ data-sheets / calculations etc. submitted along with the offer shall not be taken cognizance off.

e) The offered materials shall be either equivalent or superior to those specified in the specification & shall meet the specified / intended duty requirements. In case the material specified in the specifications is not compatible for intended duty requirements then same shall be resolved by the bidder with BHEL during the pre-bid discussions, otherwise BHEL / Customer's decision shall be binding on the bidder whenever the deficiency is pointed out.

For components where materials are not specified, same shall be suitable for intended duty, all materials shall be subject to approval in the event of order.

f) The commissioning spares shall be supplied on 'As Required Basis' & prices for same included in the base price itself.

g) All sub vendors shall be subject to BHEL / CUSTOMER approval in the event of order.

h) Guarantee for plant/equipment shall be as per relevant clause of GCC / SCC / Other Commercial Terms & Conditions

i) In the event of order, all the material required for completing the job at site shall be supplied by the bidder within the ordered price even if the same are additional to approved billing break up, approved drawing or approved Bill of quantities within the scope of work as tender specification. This clause will apply in case during site

commissioning, additional requirements emerges due to customer and / or consultant's comments. No extra claims shall be put on this account

j) Schedule of drawings submissions, comment incorporations & approval shall be as stipulated in the specifications. The successful bidder shall depute his design personnel to BHEL's / Customer's / Consultant's office for across the table resolution of issues and to get documents approved in the stipulated time.

k) As built drawings shall be submitted as and when required during the project execution.

l) The bidder has not tempered with this compliance cum confirmation certificate and if at any stage any tempering in the signed copy of this document is noticed then same shall be treated as breach of contract and suitable actions shall be taken against the bidder.

m) Successful bidder shall furnish detailed erection manual for each of the equipment supplied under this contract at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

n) Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.

o) In case vendor submits revised drawing after approval of the corresponding drawing, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion.

PRE-BID CLARIFICATION SCHEDULE

S. NO.	SECTION/CLAUSE/PAGE NO.	STATEMENT OF THE REFERRED CLAUSE	CLARIFICATION REQUIRED

The bidder hereby clarifies that above mentioned are the only clarifications required on the technical specification for the subject package.

Signature: _____

Name: _____

Designation: _____

Company: _____

Date: _____

Company Seal

NO DEVIATION CERTIFICATE

SL NO	VOULME / SECTION	PAGE NO.	CLAUSE NO.	TECHNICAL SPECIFICATION/ TENDER DOCUMENT	COMPLETE DESCRIPTION OF DEVIATION	COST OF DEVIATION	PORTION OF PRICE SCHEDULE ON WHICH COST OF DEVIATION IS APPLICABLE	NATURE OF COST OF DEVIATION (POSITIVE/ NEGATIVE)	WHETHER COST OF DEVIATION INCLUDED/ EXCLUDED IN PRICE BID	REMARKS
TECHNICAL DEVIATIONS										
COMMERCIAL DEVIATIONS										

PARTICULARS OF BIDDERS/ AUTHORISED REPRESENTATIVE

NAME	DESIGNATIONS	SIGN & DATE	COMPANY SEAL

NOTES:

1. Cost of withdrawal of deviation will be applicable on the basic price (i.e. excluding taxes, duties & freight) only.
2. All the bidders have to list out all of their Technical & Commercial Deviations (if any) in detail in the above format.
3. Any deviation not mentioned above and shown separately or found hidden in offer, will not be taken cognizance of.
4. Bidder shall submit duly filled unpriced copy of above format indicating "quoted" in "cost of withdrawal of deviation" column of the schedule above along with their Techno-commercial offer, wherever applicable. In absence of same, such deviation (s) shall not be considered and offer shall be considered in total compliance to NIT.
5. Bidder shall furnish price copy of above format along with price bid.
6. The final decision of acceptance/ rejection of the deviations quoted by the bidder shall be at discretion of the Purchaser.
7. Bidders to note that any deviation (technical / commercial) not listed in above and asked after Part I opening shall not be considered.
8. For deviations w.r.t. Credit period, Liquidated damages, Firm prices if a bidder chooses not to give any cost of withdrawal of deviation loading as per Annexure-VII, will apply. For any other deviation mentioned in un-priced copy of this format submitted with Part-I bid but not mentioned in priced copy of this format submitted with Priced bid, the cost of withdrawal of deviation shall be taken as NIL.
9. Any deviation mentioned in priced copy of this format, but not mentioned in the un-priced copy, shall not be considered.
10. All techno-commercial terms and conditions of NIT shall be deemed to have been accepted by the bidder, other than those listed in unpriced copy of this format.
11. Cost of withdrawal is to be given separately for each deviation. In no event bidder should club cost of withdrawal of more than one deviation else cost of withdrawal of such deviations which have been clubbed together shall be considered as NIL.
12. In case nature of cost of withdrawal (positive/negative) is not specified it shall be assumed as positive.
13. In case of discrepancy in the nature of impact (positive/ negative), positive will be considered for evaluation and negative for ordering.

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STAND BY			
		3A	3B	4	5	6=3Ax4x5
1	**AC-Plant-1: (CENTRAL CHILLED WATER SYSTEM FOR MAIN CR AREAS COMMON FOR UNIT-1&2.)**					
1.1	Water chilling machine -Screw chiller	1	1		1	
1.2	AHUs for Common control room areas, CER, computer room etc.	2	2		1	
1.3	AHUs for 8.5 m battery charger & UPS room	1	1		1	
1.4	Cooling tower fans for AC plant	1	1		1	
1.5	Condenser water pumps for AC plant	1	1		1	
1.6	Chilled water pumps for AC plant	1	1		1	
1.7	Fresh air fans for above AHU rooms	4	0		1	
2	**AC PLANT-2 (ESP Building- UNIT-1)**					
2.1	Water cooled DX condensing machine -Screw	1	1		1	
2.2	AHUs for ESP control room	1	1		1	
2.3	Cooling tower fans for AC plant	1	1		1	
2.4	Condenser water pumps for AC plant	1	1		1	
2.5	Fresh air fans for above AHU rooms	2	0		1	
3	**AC PLANT-3 (ESP Building- UNIT-2)**					
3.1	Water cooled DX condensing machine -Screw	1	1		1	
3.2	AHUs for ESP control room	1	1		1	
3.3	Cooling tower fans for AC plant	1	1		1	
3.4	Condenser water pumps for AC plant	1	1		1	

S.NO.	DESCRIPTION OF EQUIPMENT	NO OF EQUIPMENT		TOTAL GUARANTEED POWER CONSUMPTION FOR EACH EQUIPMENT AT MOTOR INPUT TERMINAL AND CONTROL PANEL (IN KW)	DUTY FACTOR	TOTAL KW
		WORKING	STAND BY			
		3A	3B	4	5	6=3Ax4x5
3.5	Fresh air fans for above AHU rooms	2	0		1	
4	**AC PLANT-4 (Service Building)**					
4.1	Water cooled package AC (20TR)	10	10		1	
4.2	Water cooled package AC (15TR)	10	10		1	
4.3	Fresh air fans for above PAC room.	20	0		1	
4.4	Cooling tower fans for AC plant	1	1		1	
4.5	Condenser water pumps for AC plant	1	1		1	
				TOTAL (KW)		**960**

NOTES:

1. Estimated power consumption (EPC) figure for the system (for working drives only) has been considered as **960** KW. So long bidder's quoted guaranteed power consumption (GPC) above remains within this EPC, there will be no technical loading of bid on power consumption for evaluation.
   However, if bidder's quoted GPC exceeds EPC, there shall be technical loading of bid for evaluation @Rs 3,56,607/- per KW of additional power over EPC.
2. Bidder’s guaranteed power consumption at motor input terminals (not shaft power) as furnished in relevant schedule shall be demonstrated by the successful bidder during performance testing at works/ site. In case power consumption is noted higher than EPC / bidder's quoted GPC whichever is higher, during inspection/ PG test, penalty @Rs 3,56,607/- per KW shall be levied on vendor.

APPENDIX - I

MASTER DRAWING LIST WITH STATUS

(COPY OF APPROVED DRAWING / DOCUMENTS ARE ENCLOSED WITH THE SPECIFICATION)

S. NO.	DOCUMENT NO	DOCUMENT TITLE	REV NO	APPROVAL STATUS	SCHEDULE SUBMISSION DATE FROM LOA
1	PE-V0-412-553-A001	SUB-VENDOR LIST WITH INSPECTION CATEGORIZATION PLAN FOR AC SYSTEM	0	Approved	
2	PE-V0-412-553-A002	QAP OF SCREW CHILLER PACKAGE	2	Approved	
3	PE-V0-412-553-A003	QAP OF WATER-COOLED PACKAGE AC	0	Approved	
4	PE-V0-412-553-A005	QAP OF CONDENSING UNIT FOR AIR CONDITIONING SYSTEM	2	Approved	
5	PE-V0-412-553-A006	QAP OF AIR HANDILING UNIT	1	Approved	
6	PE-V0-412-553-A007	QAP OF PUMPS FOR AIR CONDITIONING SYSTEM	2	Approved	
7	PE-V0-412-553-A008	QAP OF COOLING TOWER FOR AIR CONDITIONING SYSTEM	0	Approved	
8	PE-V0-412-553-A009	QAP OF MOTORS FOR AIR CONDITIONING SYSTEM	0	Approved	
9	PE-V0-412-553-A011	HEAT LOAD CALCULATION FOR MAIN PLANT, ESP / VFD CONTROL ROOMS FOR AIR CONDITIONING SYSTEM	1	Approved	
10	PE-V0-412-553-A012	OPERATION & CONTROL PHILOSPHY FOR AIR CONDITIONING SYSTEM	1	Approved	
11	PE-V0-412-553-A013	PRESSURE DROP CALCULATIONS FOR CHILLED AND CONDENSER WATER PIPING FOR AIR CONDITIONING SYSTEM	0	Approved	
12	PE-V0-412-553-A014	TDS AND GA OF SCREW CHILLER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	1	Approved	
13	PE-V0-412-553-A017	TDS OF CONDENSING UNIT (DX) FOR AC SYSTEM	0	Approved	
14	PE-V0-412-553-A018	TDS AND GA OF COOLING TOWER ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	1	Approved	
15	PE-V0-412-553-A019	TDS AND GA OF AIR HANDLING UNITS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	1	Approved	
16	PE-V0-412-553-A020	TDS AND GA OF CONDENSER AND CHILLEDWATER PUMPS ALONG WITH FOUNDATION DETAILS FOR AIR CONDITIONING SYSTEM	2	Approved	
17	PE-V0-412-553-A022	TDS AND GA OF MOTOR (PUMP, COOLING TOWER, AHU)	1	Approved	
18	PE-V0-412-553-A023	TDS OF INSULATION MATERIAL (DUCT INSULATION, DUCT LINING, PIPE INSULATION) FOR AC SYSTEM	0	Approved	
19	PE-V0-412-553-A024	TDS AND GA OF FRESH AIR FANS FOR AIR CONDITIONING SYSTEM	1	Approved	
20	PE-V0-412-553-A025	TDS AND GA OF NON-CHEMICAL WATER TREATMENT FOR AIR CONDITIONING SYSTEM	0	Approved	
21	PE-V0-412-553-A026	TDS & GAD OF WATER-COOLED	0	Approved	

		PACKAGED AC UNIT ALONG WITH FOUNDATION DETAIL			
22	PE-V0-412-553-A027	TDS AND GA OF FOR 3-WAY MIXING VALVE FOR AIR CONDITIONING SYSTEM	0	Approved	
23	PE-V0-412-553-A028	TDS AND GA OF HEATERS AND HUMIDIFIER FOR AIR CONDITIONING SYSTEM	1	Approved	
24	PE-V0-412-553-A029	TDS AND GA OF FIRE DAMPER WITH ACTUATOR FOR AIR CONDITIONING SYSTEM	0	Approved	
25	PE-V0-412-553-A030	TDS AND GA OF VALVEES (BALANCING VALVE, GATE VALVE, CHECK VALVE, Y ATRAINER) FOR AIR CONDITIONING SYSTEM	1	Approved	
26	PE-V0-412-553-A031	TDS AND GA OF SUPPLY / RETURN AIR DIFFUSER/GRILL FOR AIR CONDITIONING SYSTEM	1	Approved	
27	PE-V0-412-553-A032	TDS OF GI SHEET FOR AC SYSTEM	0	Approved	
28	PE-V0-412-553-A033	TDS OF PIPE FOR AC SYSTEM	1	Approved	
29	PE-V0-412-553-A034	TDS AND GA OF EXPANSION TANK, MAKEUP WATER TANK AND SOFT WATER TANK FOR AIR CONDITIONING SYSTEM	1	Approved	
30	PE-V0-412-553-A035	TDS AND GA OF FILTERS FOR AIR CONDITIONING SYSTEM	0	Approved	
31	PE-V0-412-553-A037	PID FOR MAIN PLANT, SERVICE BUILDING ESP ETC FOR AIR CONDITIONING SYSTEM	2	Approved	
32	PE-V0-412-553-A039	AC DUCT ,PIPING & AHU ROOM LAYOUT WITH FOUNDATION DETAIL FOR UPS BATTERY CHARGER ROOM AT 8.5 M & SWAS ROOM AT 0 M.	1	Approved	
33	PE-V0-412-553-A040	AC DUCT LAYOUT DRAWING FOR CONTROL ROOM AREA 17 M ALONG WITH AHU ROOM & PIPING LAYOUT WITH FOUNDATION DETAILS.	3	Approved	
34	PE-V0-412-553-A040A	DUCTING LAYOUT IN COMMON CONTROL ROOM AREA (17.0M - TG BUILDING) FOR AC SYSTEM	1	Approved	
35	PE-V0-412-553-A041	AC DUCT & PIPING LAYOUT DRAWING FOR ESP CONTROL ROOM AREA ALONG WITH AHU/PU ROOM LAYOUT WITH FOUNDATION DETAILS FOR INDOOR & OUT DOOR UNITS.	2	Approved	
36	PE-V0-412-553-A042	AC DUCT & PIPING LAYOUT DRAWING FOR SERVICE BUILDING WITH AHU ROOM LAYOUT & FOUNDATION DETAILS.	0	Approved	
37	PE-V0-412-553-A043	AC DUCT & PIPING LAYOUT DRAWING FOR ADMINISTRATION BUILDING WITH AHU ROOM LAYOUT & FOUNDATION DETAILS.	1	Approved	

38	PE-V0-412-553-A043A	DUCTING LAYOUT IN ADMIN BUILDING FOR AC SYSTEM	1	Approved	
39	PE-V0-412-553-A045	AC PLANT ROOM LAYOUT & COOLING TOWER AREA LAYOUT WITH COMPLETE WITH PIPING & FOUNDATION DETAIL OF ALL EQUIPMENT.	2	Approved	
40	PE-V0-412-553-A048	TDS OF LIFTING EQUIPMENTS FOR AC SYSTEM	0	Approved	
41	PE-V0-412-553-A049	TDS OF AIR CURTAIN FOR AC SYSTEM	0	Approved	
42	PE-V0-412-553-A052	SPLIT AC SCHEDULE ALONGWITH HEAT LOAD CALCULATION FOR AUXILIARY BUILDING	0	Approved	
43	PE-V0-412-553-A057	PG/ DEMONSTRATION TEST PROCEDURE FOR AIR CONDITIONING SYSTEM	0	Approved	
44	PE-V0-412-553-A059	TDS OF FCU FOR AC SYSTEM	0	Approved	
45	PE-V0-423-553-A038	TYPICAL DETAILS DUCT FABRICATION DRAWING / SUPPORT / ERRECTION, INSULATION OF DUCTING / PIPING & CHILLED WATER EQUIPMENTS	0	Approved	
46	PE-V0-412-553-A055	ELECTRICAL LOAD LIST FOR AC SYSTEM		Finalized	MCC has been manufactured based on these loads and no change in the Load Data shall be acceptable.
47	PE-V0-412-553-A056	INSTRUMENT & CONTROL CABLE SCHEDULE FOR AC SYSTEM		Finalized	Minor Changes if required to be done by the bidder during detail engineering.
48	*PE-V0-412-553-A011A	HEAT LOAD CALCULATION FOR SERVICE BUILDING	0	To Be Submitted	4 Weeks
49	*PE-V0-412-553-A021	TDS AND GA OF PAC / SPLIT AIR CONDITIONER**	1	To Be Submitted	4 Weeks
50	*PE-V0-412-553-A036	TDS FOR INSTRUMENTS (GAUGES-TEM, PR, LVL, PRES: SWITCH-TEMP, LVL, DP: SENSORS-TEMP, HUM ETC) FOR AIR CONDITIONING SYSTEM	0	To Be Submitted	4 Weeks
51	*PE-V0-412-553-A042A	DUCTING LAYOUT IN SERVICE BUILDING FOR AC SYSTEM	0	To Be Submitted	6 Weeks
52	*PE-V0-412-553-A046	TDS FOR VFD FOR AC SYSTEM	1	To Be Submitted	6 Weeks
53	PE-V0-412-553-A058	O & M MANUAL OF AC SYSTEM		To Be Submitted	10 Weeks
54	*PE-V0-412-553-A061	I/O LIST & DRIVE LIST FOR AC SYSTEM	1	To Be Submitted	6 Weeks
55	*PE-V0-412-553-A062	TDS OFJUNCTION BOX FOR AC SYSTEM		To Be Submitted	6 Weeks

56	*PE-V0-412-553-A063	ELECTRICAL EQUIPMENT AND CABLE TRAY LAYOUT DRAWING		To Be Submitted	8 Weeks
57	*PE-V0-412-553-A064	CABLE INTERCONNECTION DIAGRAM FOR AC SYSTEM		To Be Submitted	8 Weeks
58	PE-V0-412-553-A065	ERECTION MANUAL FOR EACH EQUIPMENTS FOR AC SYSTEM		To Be Submitted	10 Weeks

Note:

1. Drawing / Document shall be uploaded by the successful bidder on WRENCH /DMS. Procedure for the same will be informed after award of contract. Document submission through mail is not acceptable.

2. Bidder to furnish hardcopies for above drawings / documents as per the dwg. / documents distribution as per project requirement.

3. **Split AC / Ductable Split / Cassette AC shall be provided & designed with maximum star rating as available in line with energy conservation policies notified by BEE, GOI at the time of supply.

4. Drawings shall be prepared in auto-cad latest edition and shall be shared with BHEL during detail engineering of review.

5. Submission and approval of Drawings / documents marked with "*" basic engineering documents and are linked with payment against engineering charges.

6. The drawings/ documents submitted by vendor shall be complete in all respects with revised drawing submitted incorporating all comments. Any incomplete drawing submitted shall be treated as non- submission with delays attributable to vendor's account. For any clarification/discussion required to complete the drawings, the bidder shall himself depute his personal to BHEL / Customer's place as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

7. Detailed erection manual for each of the equipment as well as complete system supplied under this contract shall be submitted at least 3 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.

8. The Field Quality Plan of bidder shall also be submitted by the successful bidder during detail engineering for customer's / consultant's approval. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

9. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.

10. All possible efforts shall be made by the bidder to get the approval of drawings and documents from BHEL / customer / consultant at the earliest and the documents prepared / generated by them or their sub-vendors shall be checked by their competent authority before submission to BHEL.

11. Bidder to resubmit documents within one week after receipt of comments.

12. Revision made by the bidder in any drawings and documents shall be highlighted by indicating the no. of revisions in a triangle without fail so that the minimum time is required by BHEL to review the drawings and documents. Drawings/ documents to be submitted for BHEL review / approval shall be under Revision A, B, C… etc. while drawings /documents to be submitted thereafter for customer's approval after purchaser's approval shall be under R-0, 1, 2, 3 …. etc.

13. All drawings and documents including general arrangement drawing, data sheet, calculation etc. shall be furnished to BHEL during detailed engineering stage and shall include / indicate the following details for clarity w.r.t. inspection, construction, erection and maintenance etc.: -

    - All drawings and documents shall bear BHEL's title block and drawing / document number. However, BHEL's drawing / document numbering scheme shall be furnished to the successful bidder after the placement of L.O.I.

    - All drawings and documents shall indicate the list of all reference drawings including general arrangement.

    - All drawings shall include / show plan, elevation, side view, cross - section, skin section, blow - up view, all major self-manufactured and bought out items shall be labelled and included in BOQ / BOM in tabular form.

    - Specification / schedule of painting shall be made as a part of general arrangement drawing of each item

    - All text/ numeric in the document / drawings to be generated by the successful bidder will be in English language only.

REVISED TECHNICAL DATASHEET FOR SCREW CHILLER IN LINE WITH COMMENTS IS BEING SUBMITTED AS PER COMMENTS. BEING LONG LOAD ITEM, QAP OF CHILLER IS ALSO ENCLOSED FOR YOUR REVIEW AND APPROVAL.

DOC MENT IS APPRO ED IDE TANGEDCO LETTER NO. CE/E/P1/SE/E/ T&H(P)/EE-6/AEE/E/P/F.ENNORE SE DRG. APPL./D.69 /19 DT. 30.04.2019

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2018.12.03 19:03:36 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

JOB No.	**412**		
STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A002**	Rev: 02
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**QAP of Screw Chiller Package**	
PREPARED BY	MK	-SD-	29/08/2018
CHECKED BY	RK	-SD-	29/08/2018
APPROVED BY	RK	-SD-	29/08/2018

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : AIR CONDITIONING SYSTEM
CUSTOMER : TANGEDCO
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHEL

Enriching Lives

KIRLOSKAR CHILLERS PRIVATE LIMITED

QUALITY ASSURANCE PLAN : CHILLER UNIT ASSEMBLY.					DOCUMENT NO. PE-V0-412-553-A002, REV. 00					Page 1 of 3
Sr No	Item Description	CHECK			Acceptance Norms.	Format of record	Inspection By			Remarks
		Characteristics	Method	Extent			M	C	I	
1	Compressor Assembly									
1a	Compressor Assembly	Pressure Test	Certificate Review	100%	Manufacturer Specification	Manufacturer certificate.	R/P	R	R	
1b	Motor for compressor	Motor Insulation Test	Meager	100%	KCPL specification	Inspection Report	P	R	R	
2-A	Heat Exchanger Assembly (Evaporator for all chillers & Condenser for water cooled chiller models)									
2a	Raw Material Inspection for shell plate / Pipe, tube sheet plate, tubes.	Surface defects	Visual	Major	Drawing, Material specification.	Inspection Report	P	R	R	
		Dimensions	Measurement	Major			P	R	R	
		MTC	Review	100%		MTC	R / P	R	R	
2b	Shell inspection	Dimensions	Measurement	100%	Drawing	Insp. Report. (Inspection Stage NA if Pipe is used.)	P	R	R	
		Profile	Template	100%			P	R	R	
		Internal cleaning	Visual	100%			P	R	R	
		Welding Inspection	Visual, DPT	100%	ASME SEC V		P	R	R	
2c	Tube sheet	Dimensions	Measurement	100%	Drawing	Insp. Report	P	R	R	
2d	Nozzle Inspection	Dimensions	Measurement	Major	Drawing	Insp. Report	P	R	R	
2e	Inspection before pressure Test.	Overall dimensions	Measurement	Random	Drawing	Insp. Report	P	R	R	
		Fitment of pr. parts	Visual	100%	Drawing		P	R	R	
		Visual inspection	Visual	100%			P	R	R	
2f	Pneu. Test: Ref. Side	Leakage/ Pr. drop	Visual	100%	No any leakage and/ or pressure drop	Insp. Report	P	R	R	
	Hydro Test: Water side	Leakage/ Pr. drop	Visual	100%		Insp. Report	P	R	R	

VIPIN NAUNI 2018.10.16 16:28:49 +05'30'

PROJECT : 2X660 MW ENNORE TPS
PACKAGE : AIR CONDITIONING SYSTEM
CUSTOMER : TANGEDCO
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHEL

Kirloskar
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QUALITY ASSURANCE PLAN : CHILLER UNIT ASSEMBLY.					DOCUMENT NO. PE-V0-412-553-A002, REV. 00					Page 2 of 3
Sr No	Item Description	CHECK			Acceptance Norms.	Format of record	Inspection BY			Remarks
		Characteristics	Method	Extent			M	C	I	
3	Dished end Assly									
3a	Raw Material Inspection	Surface defects	Visual	Major	Drawing, Material specification.	Inspection Report, MTC	P	R	R	
		MTC	Review	100%			R	R	R	
3b	Final Inspection	Dimensions	Measurement	Major		Inspection Report	P	R	R	
3c		Welding Inspection	Visual, DPT	100%	ASME SEC V	Inspection Report	P	R	R	
4	Panel Inspection									
4a	Panel inspection	Visual, dimensions	Visual, Measurement	100%	KCPL drgs / specification	Insp. Report.	P	R	R	
		Component Layout					P	R	R	
		Wiring check					P	R	R	
5	Chiller Unit Assembly.									
5a	Inspection before pressure Test.	Overall dimensions	Measurement	Random	Drawing	Insp. Report	P	R	R	
		Fitment of pr. parts	Visual	100%	Drawing		P	R	R	
		Visual inspection	Visual	100%			P	R	R	
5b	Pneumatic Pressure Test (Refrigerant side)	Leakage/ Pr. drop	Visual	100%	No any leakage and/ or pressure drop	Insp. Report	P	R	R	
5c	Performance testing	Performance	Run test.	As per remark	KCPL specification	Log sheet	P	W	W	CHP One per model at 100% load at design condition.
5d	Final Inspection	Finish Painting	Visual & DFT	100%	KCPL specification	Insp. Report	P	R	R	
		Insulation	Visual	100%						
		Name plate, labels	Visual	100%						

Bharat Heavy Electricals Limited PPEI Sector-16A NOIDA 201 301 PEM/Mech. Aux.

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PROJECT : 2X660 MW ENNORE TPS
PACKAGE : AIR CONDITIONING SYSTEM
CUSTOMER : TANGEDCO
CONSULTANT : DESEIN PRIVATE LIMITED
EPC CONTRACTOR : BHEL

Enriching Lives

QUALITY ASSURANCE PLAN : CHILLER UNIT ASSEMBLY.	DOCUMENT NO. PE-V0-412-553-A002, REV. 00	Page 3 of 3

Legends used:

M	Manufacturer (KCPL or KCPL sub vendor)
C	BHEL / ROOTS COOLING SYSTEM
I	TANGEDCO / DESEIN
P	Perform Activity should be performed & inspected.
W	Witness Authorized inspector's witness point. Can not proceed without clearance
R	Review Documents will be submitted to authorized inspector for review.
NA	Not Applicable

Abbreviations:

KCPL	Kirloskar Chillers Pvt. Ltd.
MTC	Material Test Certificate.
DPT	Die penetrant testing.
NDE	Non Destructive examination.

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REV	REVISION DESCRIPTION	DATE	APPROVED BY			ACCEPTED BY
04	Inspection stages modified based on customer feedbacks	25.03.12	DVD (QA)	Checked & Approved By : DVD		
03	Inspection Stages Updated	05.02.10	DVD (QA)		4.7.16	
02	Inspection Stages Updated	10.09.09	DVD (QA)	QA Plan Prepared By : RVH		
01	Inspection stages modified. Document details added.	15.07.09	DVD (QA)			

WORK INSTRUCTION

Document No.: WI / MF / NTPC / 10			**Rev.:** 00	**Effective from :** 01.12.2015
Work Inst. Title : Painting				**Page No :** 1 of 1
Department / Function : Manufacturing				
Responsibility : Member Manufacturing & Member Q. A.				

Sr No	Activity	Photograph	Activity	Photograph
I	SURFACE PREPRATION			
1, 2	All the surface to be painted shall be properly degreased with thinner.		The surfaces shall be cleaned with wire brush / sand paper till the surface to be painted is free of all visible residues and any rust.	
II	PRIMER PAINTING			
3, 4	Cover the surfaces with protective cover where painting is not required; such as panel screen, switches, etc. Apply grease on name plates, lables, etc.		Take the required quantity of primer by mixing with respective hardener maintaining mixing ratio as specified by paint manufacturer.	
5,6	Apply primer on all surfaces uniformly at ambient temperature		Allow the primer to dry completely before going for further operation.	
7	Measure the Dry File Thickness (DFT) of the primer. The DFT of the primer shall be 30 microns minimum. If DFT is observed is less than 30 microns, another coat of primer is to be applied wherever required.			
III	APPLICATION OF FINISH PAINT			
8,9	Take the required quantity of finish paint by mixing with respective hardener maintaining mixing ratio as specified by paint manufacturer.		Apply a coat of paint uniformly at ambient temperature over all the surfaces. Allow this paint to dry before application of second coat.	
10,11	Second coat of finish paint shall be applied at ambient temperature and allow to dry completely.		Ensure that the dry film thickness achieved is minimum 70 microns all over incluisve of primer paint DFT.	
12,13	If the dry film thickness is less than 70 micron, one more coat of finish paint shall applied where ever required.		Again recheck the DFT to ensure required paint thickness is achieved.	
14	Uncover the covered surfaces and wipe off grease from applied surfaces with a clean cloth. Carry out visual inspection, do the final touch up with finish paint where ever necessary. .			
15	Standard Paint shade for all types of chillers shall be RAL 7035			

Prepared By : Member Manufacturing	Approved By : Head Manufacturing

KIRLOSKAR CHILLERS PRIVATE LIMITED
A Kirloskar Group Company

Enriching Lives

WORK INSTRUCTION

Document No.: WI / QA / 06		Rev.: 02	Effective from : 20.11.2015
Work Inst. Title :	CHILLER UNIT PERFORMANCE TEST		Page No : 1 of 1
Department / Function : Member Manufacturing & Member Q. A.			
Responsibility : Member Manufacturing & Member Q. A.			

Sr No	Activity
1	SCOPE
	This procedure outlines the process to be followed for conducting performance test for the chillers.
2	PRODUCTS COVERED
	2.1 All water cooled screw and centrifugal chillers
	2.2 All air cooled screw chillers
3	EQUIPMENTS REQUIRED
	3.1 Temperature sensors used on the chiller unit shall be used for chiller & condenser water temperature measurement as well as ambient temperature in case of air cooled chiller.
	3.2 Calibrated energy meter for measurement of power consumption.
	3.2 Calibrated flow meters for measurement of water flow rate.
4	TEST PROCEDURE
	4.1. After vacuumizing; chiller unit is ready for performance test. Hook up the unit on test bed & complete power and control connections to establish power supply to the unit.
	4.3. Charge the suitable lubricating oil as per requirements. Start the water pumps & adjust the required water flows for the evaporator & condenser. Veriation in the Water flow observed on display should not exceed ±5% of specified flows. Average reading of the flow to be recorded in the log sheet. Static charging of refrigerant is done as per requirement. After completion of refrigerant charging switch ON the compressor.
	4.4. The unit is kept running till following temperatures are achieved close to design/operating requirment. For water cooled chiller - desired chiller water outlet & condenser water inlet temperature For air cooled chiller - desired chiller water outlet temperature & condensing temperature Evaporator water outlet temperature for water cooled as well as air cooled chillers & condenser water inlet temperature for water cooled chillers should be maintained within tolerance of ±0.3 deg. C of desired temperatures. Unit is kept running at this stady state condition.
	4.5. For water cooled chillers, condenser inlet water temperature is maintained by bypassing the condenser outlet water to the cooling tower. Flow to the cooling tower is regulated by the regulating valve in the condenser outlet line to the water tank & speed of cooling tower fan. In the present test bed setup, it is not possible to simulate design ambient temperature for air cooled chillers. Performance shall be demonstrated at available ambient temperature. Loading of the chillers is done by mixing high temperature water to the chiller inlet water. Mixing is controlled by regulating / bypassing the chiller outlet water to the water tank & adjusting the speed of the mixing pump.
	4.6. When the unit is running at steady state condition 4 representative readings of system parameters (Water as well as refrigerant side) at an interval of 5 minutes are taken to evaluate the performance of the chiller at the available conditions. All readings of the performance testing are recorded in the appropriate log-sheet. After these readings unit is switched off. Water pumps are kept running for 5 minutes after switching off the chiller unit.
5	ACCEPTANCE CRITERIA
	The chiller unit has passed the performance test if
	5.1 The capacity of the unit is more than 95% of the rated capacity.
	5.2 The specific power consumption (lkW/TR) of the unit is less than 105% of the rated ikw/TR.
6	Procedure stages 4.4 to 4.6 will be offered for witness; in case of any IIIrd party / customer / consultant witnessing the performance run test.

Prepared By : Member Quality Assurance	Approved By : Head Quality Assurance

DOC MENT IS APPRO ED IDE TANGEDCO LETTER NO. CE/E/P1/SE/E/ T&H(P)/EE-6/AEE/E/P/F.ENNORE SE DRG. APPL./D.67 /19 DT. 30.04.2019

01/09/2018	00	First Submission	MK	RK	RK
Date	Rev	Description of Revision	ALT	CHD	APPD

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
JOB No. **412**	
STATUS **CONTRACT**	**DOC. NO: PE-V0-412-553-A003** Rev: **00**
PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**QAP OF WATER COOLED PACKAGED AC**

PREPARED BY	MK	-SD-	01/09/2018
CHECKED BY	RK	-SD-	01/09/2018
APPROVED BY	RK	-SD-	01/09/2018

VOLTAS

MANUFACTURE'S NAME & ADDRESS
M/S VOLTAS LIMITED (DPG) DADRA

MANUFACTURING QUALITY PLAN

ITEM : PAC (WATER COOLED)

QP.NO. : PAC/02

REV. : 00

DATE : 29.08.2018

NOTE : THIS IS A STD QAP APPLICABLE FOR W/C PACs (ALL MODELS)

PAGE : 1 OF 1

SL.NO 1	TEST 2	CHARACTERISTICS CHECKED 3	CATEGORY 4	TYPE / METHOD OF CHECK 5	EXTENT OF CHECK 6	REFERENCE DOCUMENT 7	ACCEPTANCE NORMS 8	FORMAT OF RECORDS 9	AGENCY 10			REMARK 11
									P	W	V	
1	TEST PLAN :- WATER COOLED PAC											
1.1	LEAK TEST OF REFRIGERENT SYSTEM	LEAK TIGHTNESS PNEUMATIC	MAJOR / CRITICAL	SOAP TEST AT 300 PSI	100%	W/AC:QC:PC:103:002	NO LEAKAGE AT 300 PSI	TEST CARD	3	-	2	
1.2	LEAK TEST OF REFRIGERENT SYSTEM	LEAK TIGHTNESS PNEUMATIC	MAJOR / CRITICAL	ELT (ELECTRONIC LEAK TEST)	100%	W/AC:QC:PC:103:003	LEAK RATE LESS THAN 3 Gm/a AT 300 PSI (5% R-22)	TEST CARD	3	-	2	
1.3	VACCUM	VACCUME PULL	MAJOR	MEASURMENT	100%	W/AC:QC:PC:103:0014	UPTO 400 MICRON	TEST CARD	3	-	2	
1.4	VACCUM RISE	VACCUME RISE	MAJOR	MEASURMENT	100%	W/AC:QC:PC:103:004	NOT MORE THAN 600 MICRON IN 60 SEC	TEST CARD	3	-	2	
1.5	RUN TEST AFTER CHARGING	CURRENT CONSUMPTION	MAJOR	RUN TEST	100%	A:ENG:ACR:102:064	VL-DRG 156600003	TEST CARD	3	-	2	
1.6	MEGGER TEST (INSULATION RESISTANCE TEST)	INSULATION RESISTANCE AT 500 V DC	MAJOR	MEASURMENT OF IR AT 500VDC	100%	W/AC:QC:PC:103:005	NOT LESS THAN 1 M ohm	TEST CARD	3	-	2	
1.7	HV TEST	LEAKAGE CURRENT AT 1KV FOR 2 SEC	MAJOR	MEASURMENT OF LEAKAGE CURRENT	100%	W/AC:QC:PC:103:005	NOT MORE THAN 10mA	TEST CARD	3	-	2	
1.8	APPEARANCE	APPEARANCE	MAJOR	VISUAL	100%	W/AC:QC:PC:103:001	NO DAMAGE	TEST CARD	3	-	2	

LEGEND:

P: PERFORM , W: WITNESS AND V: VERIFICATION. AS APPROPRIATE,

3 - M ( )/
2 - BHEL
1 - C / TPI

DPG - QUALITY ASSURANCE
VOLTAS LTD

CUSTOMER APPROVAL

Reviewed By	Approved By	Approved Seal.

MUKESH KUMAR SINGH

Digitally signed by MUKESH KUMAR SINGH
DN: cn=MUKESH KUMAR SINGH, o=BHEL, ou=PEM, email=mukesh.kumar.singh@bhel.in, c=IN
Date: 2018.11.02 12:55:39 +05'30'

3

TANGEDCO / DESEIN COMMENTS (REV0.1): DOCUMENT SHALL BE APPROVED AFTER APPROVAL OF TECHNICAL DATASHEET.

BHEL REPLY:
TECHNICAL DATASHEET (R01) FOR CONDENSING UNIT FOR AC SYSTEM, PE-V0-412-553-A017 IS SUBMITTED FOR APPROVAL. BEING LONG LEAD ITEM, QAP OF CONDENSING UNIT IS ALSO ENCLOSED FOR YOUR REVIEW AND APPROVAL.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2019.02.06 12:25:19 +05'30'

12/09/2018	00	First Submission	MK	RK	RK
Date	Rev	Description of Revision	ALT	CHD	APPD

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

JOB No.	**412**		
STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A005**	Rev: **02**
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**QAP OF CONDENSING UNIT FOR AIR CONDITIONING SYSTEM**	

PREPARED BY	MK	-SD-	12/09/2018
CHECKED BY	RK	-SD-	12/09/2018
APPROVED BY	RK	-SD-	12/09/2018

VOLTAS

MANUFACTURE'S NAME & ADDRESS
M/S VOLTAS LIMITED
C' Building, Shreenath Industrial Estate,
Near Dadra check post,
DADRA, (U.T.OF D & N.H.)

MANUFACTURING QUALITY ASSURANCE PLAN

ITEM : WATER COOLED CONDENSING UNIT

QP.NO. : CHP/18-19/01
REV. : 00
DATE : 05.09.2018
PAGE : 1 OF 2

SL.NO	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY			REMARK
										P	W	V	
1	2	3	4	5	6		7	8	9	10			11
I	**RAW MATERIAL / BOUGHT OUT ITEMS FOR CONDENSING UNIT**				M	C							
1	CONTROL PANEL	Visual, Dimensions & Simulation test	Major	Visual, Dimensions & Simulation test	100%	-	Mfg.Drg.	Mfg.Drg	Supplier's TC	3		2	
2	MS SEAMLESS (Refrigerant Pipes)	Visual, dimensional, chemical & physical	Major	Visual, measurement. chemical, mechanical	Sample	-	ASTM A 106 GR. B (2002), Sch 40	ASTM A 106 GR. B (2002), Sch 40	Supplier's TC	3		2	
II.a	**RAW MATERIAL / BOUGHT OUT ITEMS FOR CONDENSER**												
1	Shell (Condenser)	Visual, dimensional and physical & chemical	Major	Visual measurement chemical & mechanical	Sample	-	IS 2062 / ERW IS:3589 Fe330	IS 2062 / ERW IS:3589 Fe330	Supplier's TC	3		2	
2	Tube sheet	Visual, dimensional and physical & chemical	Major	Visual measurement chemical & mechanical	Sample	-	IS 2062 GR.A	IS 2062 GR.A	Supplier's TC	3		2	
3	Rear Head	Visual Chemical Physical	Major	Visual Chemical Physical	Sample	-	IS210-FG260	IS210-FG260	Supplier's TC	3		2	
4	Front head	Dimensional Chemical Physical	Major	Measurement Chemical Physical	Sample	-	IS 2062 GR A	IS 2062 GR A	Supplier's TC	3		2	
5	Copper tube	Visual, dimensional (OD, thickness) Chemical Physical	Major	Visual, measurement, chemical & Physical	Sample	-	ASTM B75 / B111, C12200	ASTM B75 / B111, C12200	Test Certificate	3		2	

PREPARED & APPROVED BY:
RAVI SINGH
ASST.MANAGER - QA
VOLTAS LTD, DPG

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3 - M ( )/
2 - BHEL
LEGEND: 1 - C / TPI

P: PERFORM , **W:** WITNESS AND **V:** VERIFICATION. AS APPROPRIATE,

Reviewed By | Approved By | Approval Seal.

VOLTAS

MANUFACTURE'S NAME & ADDRESS
M/S VOLTAS LIMITED
C' Building, Shreenath Industrial Estate,
Near Dadra check post,
DADRA, (U.T.OF D & N.H.)

MANUFACTURING QUALITY ASSURANCE PLAN

ITEM : WATER COOLED CONDENSING UNIT

QP.NO. : CHP/18-19/01
REV. : 00
DATE : 05.09.2018

SL.NO	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	EXTENT OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORDS	AGENCY			REMARK
										P	W	V	
1	2	3	4	5	6		7	8	9	10			11
II.b	**IN-PROCESS & FINAL INSPECTION FOR CONDENSER**				M	C							
1	Welding of Tubesheet & Shell	Welding	Major	DP Test	100%	-	Voltas Procedure W/AC:QC:GE:103:003	No Welding defect	Inspection Report	3		2	
2	Expansion	% Crush	Major	Measurement	5 nos per job	-	Voltas Procedure W/ENG:ACR :102:058	5 to 8 % Crush	Inspection report / Route card	3		2	
3	Dimensional Check	Dimensions	Major	Measurement	100%	-	Voltas Drg	Voltas Drg	Inspection report	3		2	
4	Pneumatic test (shell side) At 375 PSI	Leak proofness	Critical	Pneumatic check	100%	-	Voltas Drg	No leakage	Insp. Report	3		2	
5	Pneumatic test (tube side) AT 150 PSI	Leak proofness	Critical	Pneumatic check	100%	-	Voltas Drg	No leakage	Insp. Report	3		2	
IV.a	**IN - PROCESS INSPECTION FOR CONDENSING UNIT**												
1	Pressure test of refrigerent system (Soap test)	Leak Tightness	Critical	Measurement	100%	1 no / type	At 19 Kg / sq.cm with Dry Nitrogen / Air Nitrogen / Air	No leak with soap solution	Insp.Report	3		2	
2	Pressure test of refrigerent system (Electronic leak detection)	Leak Tightness	Critical	Measurement	100%	1 no / type	At 19 Kg / sq.cm with 1.75 Kg / sq.cm freon & Dry Nitrogen / Air	Leak < 14.2 g / a with Halogen leak detector	Insp.Report	3		2	
IV.b	**FINAL INSPECTION OF CONDENSING UNIT**												
1	Complete unit Overall dimension & Visual	Dimension & Visual	Major	Measurement	100%	-	Mfg.Drg. / Appd. Drg.	Mfg.Drg. / Appd. Drg.	Insp. Report	3		2	
2	Review of Documents	Test Certificates / IR	Critical	Review	100%	-	Specification / Data sheet / Route card	Compliance to Specification / Data sheet / Route card	Inspection report / Tcs / Material TCs	3		2	
3	Painting Base Frame & Condenser	Coating thickness & finish	Major	Measurement & Visual	sample	-	Voltas Procedure	DFT Measurement Min 150 Microns C Panel Powder Coat : Min 60 Micorns	Inspection report	3		2	

PREPARED & APPRO
RAVI SING
ASST.MANAGER - QA
VOLTAS LTD, DPG

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2018.12.03
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3 - M ( )/
2 - BHEL
1 - C / TPI

LEGEND:

P: PERFORM , **W:** WITNESS AND **V:** VERIFICATION. AS APPROPRIATE,

Reviewed By | Approved By | Approval Seal.

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/TH&HYP/EE-7/M/AEE/M/F.EN SEZ STPP/D.795 /19 DT. 16/02/2019

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2019.01.18 19:51:36 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
11.12.2018	00	Second Submission	MK	RK	RK
26.09.2018	A	First Submission	MK	RK	RK

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

JOB No.	**412**		
STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A006**	Rev: **01**
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**QAP OF AIR HANDLING UNIT**	

PREPARED BY	MK	-SD-	11/12/2018
CHECKED BY	RK	-SD-	11/12/2018
APPROVED BY	RK	-SD-	11/12/2018

				Item: Air Handling Unit		QAP No.: PE-V0-412-553-A006 Rev. No. – 00 Date :- 11.09.2018		Project – 2x660 MW Ennore TPs Package: Air Conditioning System Customer:- TANGEDCO Consultant:- Desein EPC Contractor: BHEL Vendor:					
SR. NO.	**COMPONENT & OPERATION**	**CHARACTERISTICS**	**CLASS**	**TYPE OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORMS**	**FORMAT OF RECORD**	**D**	**P**	**W**	**V**	**REMARKS**
1	2	3	4	5	6	7	8	9	10				11
1.	**INCOMING MATERIAL INSPECTION**												
1.1	G.I./S.S./Pre coated/Aluminium Sheets	Dimensional & Thickness	Major	Should be uniform throughout the sheet	Sampling & review of Mfg. TC	As per approved TDS	As per approved TDS	Mfr. TC	√	3	2	1, 4	
		Visual	Major	Plating should not peel off during bending	Sampling	As per approved TDS	As per approved TDS	Mfr. TC	√	3	2	1, 4	
			Major	To be free from surface defects	Sampling	As per approved TDS	As per approved TDS	TC	√	3	2	1, 4	
1.2	Aluminium Sections	Dimensional	Major	Observation should be within the limits as per the Drg.	Sampling & review of Mfg. TC	As per approved TDS	As per approved TDS	TC	√	3	2	1, 4	
		Fitment	Major	Functional & Asthetics	Sampling	As per approved TDS	As per approved TDS	--		3	2	1, 4	
		Visual	Major	To be free from surface defects	Sampling	As per approved TDS	As per approved TDS	--		3	2	1, 4	

	Legend --				
	CR= Critical Characteristics		1 – BHEL	4 – TANGEDCO / DESEIN	P = Performing
	MA=Major Characteristics		2 – Vender		W = Witnessing
Manufacturer	MI= Minor Characteristics	BHEL	3 – Sub-vendor / Manufacturer		V = Verification

VIPIN NAUNI
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+05'30'

				Item: Air Handling Unit		QAP No.: PE-V0-412-553-A006 Rev. No. – 00 Date :- 11.09.2018		Project – 2x660 MW Ennore TPs Package: Air Conditioning System Customer:- TANGEDCO Consultant:- Desein EPC Contractor: BHEL Vendor:					
SR. NO.	**COMPONENT & OPERATION**	**CHARACTERISTICS**	**CLASS**	**TYPE OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORMS**	**FORMAT OF RECORD**	**D**	**P**	**W**	**V**	**REMARKS**
1	2	3	4	5	6	7	8	9	10				11
1.3	Filter	Dimensional	Major	Check for dimensions, type & grade	Sampling	Approved drawing & manufacturer TC	Approved drawing & manufacturer TC	TC	√	3	2	1, 4	
		Visual	Major	No damage in Media	Sampling	--	--	--	√	3	2	1, 4	
2.	**INPROCESS INSPECTION**												
2.1	PUF insulation	Density	Major	Measurement	Sampling	Approved drg./datasheet	Approved drg./datasheet	IR	√	3		1, 2, 4	
2.2	Outer casing of all section as mentioned above	Dimensional & Thickness	Major	As per internal report	Sampling	manufacturing drg.	manufacturing drg.	IR	√	3		1, 2, 4	
		Visual	Major		Sampling	--	--	IR	√	3		1, 2, 4	
2.3	Coil	No. of rows, Dimensional & Thickness	Major	Visual & measurement	100% by Mfg.	Approved drg./datasheet & TC	Approved drg./datasheet & TC	IR	√	3		1, 2, 4	
		Leakage Test	Major	Hydraulic test/Pneumatic	100% by Mfg.	325 PSI for CHW-Coil & 600 PSI for EX-coil	325 PSI for CHW-Coil & 600 PSI for EX-coil	IR	√	3		1, 2, 4	

	Legend --		1 – BHEL	4 – TANGEDCO / DESEIN	P = Performing
	CR= Critical Characteristics		2 – Vender		W = Witnessing
Manufacturer	MA=Major Characteristics MI= Minor Characteristics	B	3 – Sub-vendor / Manufacturer		V = Verification

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				Item: Air Handling Unit		QAP No.: PE-V0-412-553-A006 Rev. No. – 00 Date :- 11.09.2018		Project – 2x660 MW Ennore TPs Package: Air Conditioning System Customer:- TANGEDCO Consultant:- Desein EPC Contractor: BHEL Vendor:					
SR. NO.	**COMPONENT & OPERATION**	**CHARACTERISTICS**	**CLASS**	**TYPE OF CHECK**	**QUANTUM OF CHECK**	**REFERENCE DOCUMENT**	**ACCEPTANCE NORMS**	**FORMAT OF RECORD**	**D**	**P**	**W**	**V**	**REMARKS**
1	2	3	4	5	6	7	8	9	10				11
3.	**FINAL UNIT INSPECTION**												
3.1	Assembled/SKD	Overall dimensional/ Visual	Minor	As per inspection report	One unit of each type/size	Approved drg./datasheet	Approved drg./datasheet	IR	√	3	1, 2	4	
3.2	Free Air Run Test	Performance Report of Manufacturer	Major	Air Volume, Noise & Vibration	One unit of each type/size	Approved drg./datasheet	Approved drg./datasheet	IR	√	3	1, 2	4	**Centrifugal Fan Run Test is done at Manufacturers Works. Report of the same shall be produced during Final Unit Inspection.**
3.3	AHU knocked down supply	Completeness	Major	Verify with packing list	100%	Packing List	Packing List	IR	√	3	-	-	

VIPIN NAUNI
2019.01.18
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+05'30'

	Legend -- CR= Critical Characteristics MA=Major Characteristics		1 – BHEL 2 – Vender	4 – TANGEDCO / DESEIN	P = Performing W = Witnessing
Manufacturer	MI= Minor Characteristics	BHEL	3 – Sub-vendor / Manufacturer		V = Verification

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Document is reviewed by BHEL and found in order. Submitted for customer approval.
2020.02.13 14:57:56 +05'30'

24/10/2019	02	QAP was approved vide TANGEDCO Letter No. SE/E/Th&HyP/EE-7/M/AEE/M/F.En SEZ STPP/D.747 /18 dt.26.12.2018. Due to change in Pump make, QAP of Pump is revised and submitted for approval.	Nayab	Nayab	RKR
03/12/2018	01	Submitted for review and approval	Manish	RKR	RKR
24/10/2019	00	FIRST SUBMISSION	NAYAB	NAYAB	RK
Date	Rev	Description of Revision	ALT	CHD	APPD

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
JOB No. **412**	
STATUS **CONTRACT**	**DOC. NO: PE-V0-412-553-A007** Rev: **02**
PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**QAP OF PUMP FOR AC SYSTEM**

PREPARED BY	NAYAB	-SD-	26/04/2019
CHECKED BY	NAYAB	-SD-	26/04/2019
APPROVED BY	SKT	-SD-	26/04/2019

FLOWMORE PUMPS	**MANUFACTURER'S NAME & ADDRESS** **FLOWMORE LIMITED (UNIT – I)** 9th Mile Stone, G.T. Road Mohan Nagar, Ghaziabad (U.P.) **FLOWMORE LIMITED (UNIT – II)** 28 A, Site IV, Sahibabad Industrial Area Ghaziabad (U.P.)	**MANUFACTURING QUALITY PLAN** **(Horizontal Centrifugal Pump)**	QAP NO – 4223 REV – 02 Dt. 23.10.2019 PAGE **1** OF **2**	**CUSTOMER** : **TANGEDCO** **CONSULTANT** : **DESEIN** **EPC CONTRACTOR** : **BHEL** **PACKAGE** : **AC SYSTEM** **PROJECT** : **2X660 MW ENNORE TPS** **AC SUPPLIER** : [illegible] **DOC. NO** : **PE-V0-412-553-A007**

SL. NO	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUATUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD		AGENCY			REMARKS
					M	C / N					M	C	N	
1.	2.	3.	4.	5.	6		7.	8.	9.	D	10			11
1.	**RAW MATERIAL**													
1.1	Casing , Impeller, Shaft & Shaft Sleeve	Chemical & Physical Properties	Major	Chemical Analysis & Mechanical Hardness	Each Heat	Each Heat	Approved C.S. Drawings & Relevant IS	Approved C.S. Drawings & Relevant IS	T R	✓	P	V	V	
2	**IN PROCESS INSPECTION**													
2.1	Casing ,Impeller, Shaft & Shaft Sleeve	Surface Defects	Major	DPT on Machined Surface	100%	100%	ASTME-165	No Liner Indications	T R	✓	P	V	V	
2.2	IMPELLER	Balancing	Critical	Dynamic Balancing	100%	100%	ISO 1940 Gr. 6.3	ISO 1940 Gr. 6.3	T R	✓	P	V	V	
2.3	Casing	Soundness of Parts	Critical	Hydro Test	100%	100%	Relevant IS / HIS	No leakage	T R	✓	P	V	V	**Refer Note 1**
2.4	Shaft > 50 mm dia.	Ultrasonic Test	Critical	Ultrasonic Test	100%	100%	ASTME 114, ASME Sec V	ASTME 114, ASME Sec V	TR	✓	P	V	V	
3	**FINAL INSPECTION**													
3.1	**Pump Assembly**	Dimension Check	Major	Measurement	One of Each Type		As per Approved Drawings	As per Approved Drawings	I R	✓	P	V	V	**Refer Note 2**
3.2	**PERFORMANCE TEST OF PUMP WITH SHOP MOTOR AT REDUCED SPEED**	Discharge V/S Head Discharge V/S Eff. Discharge V/S Power Vibration, Sound Level Bearing Temp Rise.	Critical	Performance Test	100%	One of Each Type	Approved G.A. Drawings & Relevant IS / HIS	Approved G.A. Drawings & Relevant IS / HIS	I R	✓	P	V	V	**Refer Note 2**

LEGEND:
RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
M: MANUFACTURER , **C:** VENDOR **N:** **BHEL/TANGEDCO**
P: PERFORM **W:** WITNESS AND **V:** VERIFICATION
TR: INTERNAL TEST REPORTS, **IR:** INSPECTION REPORTS

MANUFACTURER / SUB-SUPPLIER	MAIN-SUPPLIER	REVIEWED BY	APPROVED BY	APPROVAL SEAL
			VIPIN NAUNI 2020.02.13 14:57:05 +05'30'	Bharat Heavy Electricals Limited PPEI Sector-16A NOIDA 201 301 PEM/Mech. Aux.

FLOWMORE PUMPS	**MANUFACTURER'S NAME & ADDRESS** **FLOWMORE LIMITED (UNIT – I)** 9th Mile Stone, G.T. Road Mohan Nagar, Ghaziabad (U.P.) **FLOWMORE LIMITED (UNIT – II)** 28 A, Site IV, Sahibabad Industrial Area Ghaziabad (U.P.)	**MANUFACTURING QUALITY PLAN** **(Horizontal Centrifugal Pump)**	QAP NO – 4223 REV – 02 Dt. 23.10.2019 PAGE **2** OF **2**	**CUSTOMER : TANGEDCO** **CONSULTANT : DESEIN** **EPC CONTRACTOR : BHEL** **PACKAGE : AC SYSTEM** **PROJECT : 2X660 MW ENNORE TPS** **AC SUPPLIER :** **DOC. NO : PE-V0-412-553-A007**

5		Painting & Packing	Major	Visual	100%	100%	As per Approved Document	As per Approved Document	---	--	P	--	--	

NOTE:

1. **TEST PRESSURE SHALL BE 1.5 TIMES THE SHUT OFF HEAD OR TWICE THE DUTY POINT HEAD WHICHEVER IS HIGHER**
2. **NOISE & VIBRATION LEVEL SHALL BE RECORDED DURING SHOP TEST FOR REFERENCE PURPOSE ONLY, HOWEVER VALUES AS PER HIS ARE GUARANTEED AT SITE ONLY.**

LEGEND:

RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
M: MANUFACTURER , C**:** VENDOR N: **BHEL/TANGEDCO**
P: PERFORM **W**: WITNESS AND **V:** VERIFICATION
TR: INTERNAL TEST REPORTS, **IR:** INSPECTION REPORTS

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MANUFACTURER / SUB-SUPPLIER	MAIN-SUPPLIER	REVIEWED BY	APPROVED BY	APPROVAL SEAL

TDS OF COOLING TOWER IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/TH&HYP/EE-7/M/AEE/M/F.EN SEZ STPP/D.726 /18 DT. 01.12.2018. QAP IS SUBMITTED FOR APPROVAL PLEASE.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2018.12.12 15:50:27 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
11.12.2018	00	Second Submission	MK	RK	RK
29.09.2018	A	First Submission	MK	RK	RK

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
JOB No.	**412**
STATUS	**CONTRACT**
	DOC. NO: PE-V0-412-553-A008 Rev: **00**
PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**QAP OF COOLING TOWER**

PREPARED BY	MK	-SD-	11/12/2018
CHECKED BY	RK	-SD-	11/12/2018
APPROVED BY	RK	-SD-	11/12/2018

MQP FOR FRP COOLING TOWER FOR AC SYSTEM (INDUCED DRAFT COUNTER FLOW)

	MANUFACTURER'S NAME & ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT: 2 X660 MW ENNORE TPS PACKAGE: AIR CONDITIONING END CUSTOMER – TANGEDCO CONSULTANT - DESEIN EPC CONTRACTOR: BHEL AC SUPPLIER –
FLOW TECH	**M/s. Flow Tech Air Pvt. Ltd.** B-105, Vishwakarma Colony, MB Road, New Delhi Pin: 110044	**ITEM** : INDUCED DRAFT FRP COOLING TOWER **TOTAL QTY: 10** Nos **MODEL:** RE1414-2L-ID (2 Nos.) RE0504-2L-ID (4 Nos.) RE1416-2L-ID (2 Nos.) RE1010-2L-ID-(2 Nos.)	**QP NO:PE-VO-412-553-A008** **REVISION:** 00 **DATE:** 12/07/18 **PAGE NO: Page 1 of 3**	

SL No.	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMES	FORMATE OF RECORD		AGENCY				REMARKS
										M	C	N	T	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)		(10)				(11)
1.	**Raw Material:**													
1.1	Chopped standard Mat the FRP	Finish	Major	Visual	One / Lot	Mfg. Std./Attached	Mfg. Std./Attached	TC/IR	√	P	V	V	V	
		Weave/Texture	Major	Visual	One/Lot	-------do-------	-------do-------	TC/IR		P	V	V	V	
		Grade	Major	Visual	One / Lot	-------do-------	-------do-------	TC/IR		P	V	V	V	
1.2	Polyester Resin For FRP Components(Casing, Basin, Fan Blades, etc.)	Color	Major	Visual	One / Lot	-------do-------	-------do-------	TC/IR		P	V	V	V	
		Viscosity	Major	Measurement	Sample	-------do-------	-------do-------	TC/IR		P	V	V	V	
		Solid Content	Major	Measurement	Sample	-------do-------	-------do-------	TC/IR		P	V	V	V	
1.3	Fan Hub & Fan	Physical Dimension, Visual	Major	Measurement & Visual Chemical	100%	Mfg. Dwg./Approved data sheet	Approved data sheet	IR	√	P	V	V	V	
1.4	Hardware and MS hot dip galvanized structure	Dimension	Major	Measurement	Sample	Mfg. Std./As per Approved data sheet	Mfg. Std./As per approved data sheet	TC/IR	√	P	V	V	V	
	Zn Coating thickness, adhesion, uniformity	Major	Measurement & Visual	Sample	IS-4759	Mfg. Std./As per Approved data sheet	Mfg. Std./As per Approved data sheet	TC/IR	√	P	V	V	V	
1.5	PVC Fills	Overall dimension	Major	Measurement	Sample	Mfg. Std./Attached	Mfg. Std./Attached	IR	√	P	V	V	V	
	PVC Eliminator	Dimension	Major	Measurement	Sample	-------do-------	-------do-------	IR	√	P	V	V	V	

MANUFACTURER/SUB-SUPPLIER	MAIN-SUPPLIER	LEGEND:	FOR BHEL USE	Doc No. PE-V0-412-553-A008 REV00…. CAT……		
SIGNATURE		* RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER, **C:** MAIN SUPPLIER, **N:** BHEL, **P:** PERFORM, **W:** WITTNESS AND **V:** VERIFICATION AS APPROPRIATE, **T:** TANGEDCO / CONSULTANT		REVIEWED BY	APPROVED BY	APPROVAL SEAL

VIPIN NAUNI
2018.12.12
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	MANUFACTURER'S NAME & ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT: 2 X660 MW ENNORE TPS PACKAGE: AIR CONDITIONING END CUSTOMER – TANGEDCO CONSULTANT - DESEIN EPC CONTRACTOR: BHEL AC SUPPLIER –
FLOW TECH LIFE MEMBER ISO 9001:2008	**M/s. Flow Tech Air Pvt. Ltd.** B-105, Vishwakarma Colony, MB Road, New Delhi Pin: 110044	**ITEM** : INDUCED DRAFT FRP COOLING TOWER **TOTAL QTY: 10** Nos **MODEL:** RE1414-2L-ID (2 Nos.) RE0504-2L-ID (4 Nos.) RE1416-2L-ID (2 Nos.) RE1010-2L-ID-(2 Nos.)	**QP NO:PE-VO-412-553-A008** **REVISION:** 00 **DATE:** 12/07/18 **PAGE NO: Page 2 of 3**	

SL No.	COMPONENT & OPERATION	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMES	FORMATE OF RECORD	AGENCY				REMARKS
									M	C	N	T	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)				(11)

2. In Process and Final Inspection:

2.1	FRP Components Casing, Basin, Fan Deck	Finish	Major	Visual	Sample / Lot	-------do-------	-------do-------	IR		P	V			
		Dimension	Major	Measurement	Sample / Lot	-------do-------	-------do-------	IR		P	V	V	V	
2.2	Water Distribution System	Overall Dimension	Major	Measurement	Random	-------do-------	-------do-------	IR	√	P	V	V	V	
2.3	Fan Assembly	Fan Blade overall dimension	Major	Measurement	100% and 10% RCS &BHEL	Approved Drg/Data Sheet.	Approved Drg./Data Sheet.	IR		P	V	V	V	
		Dynamic Balancing, Tip Clearance and Trace Variation	Major	Measurement	100%	ISO1940, Grade-6.3	ISO1940, Grade-8.3, Tip & End Clearance of 10-12 mm	Inspection Record	√	P	V	V	V	
		Identification	Major	Manual/Visual	100%	Mfg. Std.	Mfg. Std.	Inspection Record		P	V	V	V	

MANUFACTURER/SUB-SUPPLIER	MAIN-SUPPLIER	LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER, **C:** MAIN SUPPLIER, **N:** BHEL, **P:** PERFORM, **W:** WITTNESS AND **V:** VERIFICATION AS APPROPRIATE, **T:** TANGEDCO / CONSULTANT	FOR BHEL USE	Doc No. **PE-V0-412-553-A008** REV00…. CAT……		
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

Bharat Heavy Electricals Limited PPEI Sector-16A NOIDA 201 301 PEM/Mech. Aux.

VIPIN NAUNI
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MQP FOR FRP COOLING TOWER FOR AC SYSTEM (INDUCED DRAFT COUNTER FLOW)

	MANUFACTURER'S NAME & ADDRESS	MANUFACTURING QUALITY PLAN		PROJECT: 2 X660 MW ENNORE TPS PACKAGE: AIR CONDITIONING END CUSTOMER – TANGEDCO CONSULTANT - DESEIN EPC CONTRACTOR: BHEL AC SUPPLIER –
FLOW TECH LIFE MEMBER ISO 9001:2008	**M/s. Flow Tech Air Pvt. Ltd.** B-105, Vishwakarma Colony, MB Road, New Delhi Pin: 110044	**ITEM** : INDUCED DRAFT FRP COOLING TOWER **TOTAL QTY: 10** Nos **MODEL:** RE1414-2L-ID (2 Nos.) RE0504-2L-ID (4 Nos.) RE1416-2L-ID (2 Nos.) RE1010-2L-ID-(2 Nos.)	**QP NO:PE-VO-412-553-A008** **REVISION:** 00 **DATE:** 12/07/18 **PAGE NO: Page 3 of 3**	

SL No.	COMPONENT & OPERATION	CHARACTERIST-ICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORMES	FORMATE OF RECORD	AGENCY				REMARKS
									M	C	N	T	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)				(11)

1. Drive Shaft is a Part of main motor.
2. DPT of Fan Blade is not applicable as they are of FRP Blade.
3. Cooling Tower will be supplied in Knocked down condition.
4. Leak test of basin cannot be shown in factory as they are made up of sections. Once assembled it cannot be dismantle as sealant has to be applied the assembly basin cannot be transported in truck.
5. Motor shaft diameter is less than 50 mm so UT is not applicable.
6. All material as per data sheet will be final.

MANUFACTURER/SUB-SUPPLIER	MAIN-SUPPLIER	LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER, **C:** MAIN SUPPLIER, **N:** BHEL, **P:** PERFORM, **W:** WITTNESS AND **V:** VERIFICATION AS APPROPRIATE, **T:** TANGEDCO / CONSULTANT	FOR BHEL USE	Doc No. PE-V0-412-553-A008 REV00…. CAT……		
SIGNATURE				Bharat Heavy Electricals Limited PPEI Sector-16A NOIDA 201-001 PEM/Mech. Aux.	VIPIN NAUNI 2018.12.12 15:50:02 +05'30'	
				REVIEWED BY	APPROVED BY	APPROVAL SEAL

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. CE/E/P1/SE/E/ T&H(P)/EE-6/AEE/E/F.Ennore SEZ Drg Appl/D.653 /18 dt.05.12.2018.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order.
Submitted for TANGEDCO / Desein Approval.
2018.09.25 18:48:58 +05'30'

25/09/2018	A	First Submission	Manish	RKR	RKR
Date	Rev	Description of Revision	ALT	CHD	APPD

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
	I

JOB No.	**412**		
STATUS	**CONTRACT**	**PE-V0-412-553-A009**	Rev: **00**
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**QAP of Motors**	

PREPARED BY	MK	-SD-	25/09/2018
CHECKED BY	RKR	-SD-	25/09/2018
APPROVED BY	RKR.	-SD-	25/09/2018

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT : 2X660 MW ENNORE TPS
	MAKE AS PER APPROVED SUB-VENDOR LIST	Doc. No.: PE-V0-412-553-A009	Rev.: 00	PACKAGE : AIR CONDITIONING SYSTEM
		QUALITY PLAN OF MOTORS (FOR AC MOTOR BELOW 55 KW)		CUSTOMER: TANGEDCO
				CONSULTANT: DESEIN PVT. LTD
				EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LIMITED
				VENDOR :

S. No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	QUANTAM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE DOCUMENT	FORMAT OF RECORD	INSPECTIO AUTHORITY			REMARKS
								D	P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)			(11)
1	Assembly	Workmanship	Major	Visual	100%	Manufacturer Spec	Manufacturer Spec	Insp. Report	4	-	1,2,3	
		Dimensions	Major	Visual	1/Rating/Type	Manufacturer Spec / Approved Drawing / Data Sheet	Manufacturer Spec / Approved Drawing / Data Sheet	Insp. Report	4	-	1,2,3	
		Correctness completeness terminations / marking / color code	Major	Visual	100%	Manufacturer Spec / Approved Drawing / Data Sheet	Manufacturer Spec / Approved Drawing / Data Sheet	Insp. Report	4	-	1,2,3	
2	**Painting**	Shade	Major	Visual	Sample	Manufacturer Spec / Approved Drawing / Data Sheet	Manufacturer Spec / Approved Drawing / Data Sheet	Insp. Report	4	-	1,2,3	
3	Tests	Routine test	Major	Measurement	100%	IS 12615 / Approved Drawing / Datasheet	IS 12615 / Approved Drawing / Datasheet	Insp. Report	4	2*,3	1	Refer Note no. 2
		Type Test	Major	Measurement	100%	IS 12615 / Approved Drawing / Datasheet	IS 12615 / Approved Drawing / Datasheet	Insp. Report	4	-	1,2,3	Refer Note no. 3
		Dimensions and Operations	Major	Measurement	1/Rating/Type	Approved Drawing / Data Sheet	Approved Drawing / Data Sheet	Insp. Report	4	2*,3	1	Refer Note no. 2
		Nameplate details	Major	Visual	100%	IS 12615 / Approved Drawing / Datasheet	IS 12615 / Approved Drawing / Datasheet	Insp. Report	4	-	1,2,3	

Notes-

1. Routine tests on 100% motors shall be done by the vendor.
2. As per Approved Sub-vendor list with Inspection Categorization list, PE-V0-412-553-A001, BHEL shall review Routine test and Type test report for Motor rating equal and less than 30 KW. For motor rating above 30KW, BHEL shall witness the routine test. Quantum of check shall be 10% of each type and motor rating.
3. Type test certificate of the motor inspected shall not be older than 5 years from date of inspection, otherwise type test shall be conducted without any price implication.
4. Wherever customer is involved in inspection, 1 shall mean BHEL and customers both together.
5. For fan motors of rating up to 1.5 kw, only routine test certificates shall be furnished for scrutiny.
6. List of routine and type test given at the end of this document to be followed

SIGNATURE			VIPIN NAUNI 2018.09.25 18:49:15 +05'30'			
NAME					1: TANGEDCO / CONSULTANT	
					2. BHEL	P : PERFORMING
PARTY	Customer		BHEL	RCS / MANUFACTURER	3: VENDOR	W: WITNESSING
					4: MOTOR MANUFACTURER	V: VERIFICATION

	Manufacturer's Name & Address	MANUFACTURING QUALITY PLAN		PROJECT : 2X660 MW ENNORE TPS
	MAKE AS PER APPROVED SUB-VENDOR LIST	Doc. No.: PE-V0-412-553-A009	Rev.: 00	PACKAGE : AIR CONDITIONING SYSTEM
		QUALITY PLAN OF MOTORS (FOR AC MOTOR BELOW 55 KW)		CUSTOMER: TANGEDCO
				CONSULTANT: DESEIN PVT. LTD
				EPC CONTRACTOR : BHARAT HEAVY ELECTRICALS LIMITED
				VENDOR :

S. No.	COMPONENT & OPERATION	CHARACTERISTICS CHECKED	CATEGORY	TYPE / METHOD OF CHECK	QUANTAM OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE DOCUMENT	FORMAT OF RECORD	INSPECTIO AUTHORITY			REMARKS
								D	P	W	V	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)			(11)

Routine Test including Test as per BHEL Specification	Type Test
a) Visual inspection for Nameplate & Terminal box location. b) Insulation resistance test (before and after HV) c) Measurement of resistance of wdg. of stator, rotor, space heater, thermistor, RTD, BTD as applicable d) No load test at rated voltage to determine input current power and speed & direction of rotation e) Locked rotor readings of voltage, power input, starting current and starting torque at a suitable reduce voltage. f) Reduced voltage running up test g) High voltage test h) Noise level as per IS 12065. i) Vibration test as per IS 12075. j) Over speed test @120% for 2 minute.	a) Dimensions; b) Measurement of resistance of wdg. of stator, rotor, space heater, thermistor, RTD, BTD as applicable c) No load test at rated voltage to determine input current power and speed d) Reduced voltage running up test at no load (for squirrel cage motors up to 37 kW only); e) Locked rotor readings of voltage, power input, starting current and starting torque at a suitable reduce voltage. f) Full load test to determine full load Voltage, Current, Power, Speed & Slip, Efficiency, Power factor & torque. g) Performance at part load (at 100%,75%,50% load). h) Pull Out Torque Test i) Temperature rise test. j) Momentary overload test. k) Insulation resistance test. l) High voltage test. m) IP 55 test (LAB report).

VIPIN NAUNI
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SIGNATURE						
NAME					1: TANGEDCO / CONSULTANT	
					2. BHEL	P : PERFORMING
PARTY	Customer		BHEL	RCS / MANUFACTURER	3: VENDOR	W: WITNESSING
					4: MOTOR MANUFACTURER	V: VERIFICATION

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/Th&HyP/ EE-7/M/AEE/M/F.En SEZ STPP/D.663 /18 dt.20.09.2018.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Revised as per TANGEDCO / Desein Comments. Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2018.08.21 15:29:37 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
20/08/2018	1	Revised as per TANGEDCO / DESEIN Comments	Alam	Salim	PC
17/10/2017	0	Revised as per BHEL Comments	Vikas	Rajvir	PC
12/10/2017	B	Revised as per BHEL Comments	Vikas	Rajvir	PC
27/07/2017	A	First Submission	Vikas	Rajvir	PC

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
JOB No. **412**	
STATUS **CONTRACT**	**DOC. NO: PE-V0-412-553-A011** Rev: **00**
PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**HEAT LOAD CALCULATION FOR MAIN PLANT,ESP/VFD CONTROL ROOMS,SERVICE & ADMIDTRATION BUILDING**

PREPARED BY	V.K	-SD-	17/10/2017
CHECKED BY	RSK	-SD-	17/10/2017
APPROVED BY	P.C.	-SD-	17/10/2017

AC PLANT SUMMARY SHEET

SUMMARY							
Sr. No	**System**	**Location**	**Type**	**Refrigeration System**	**Cooling Tower**	**Chilled Water Pump**	**Condenser Water Pump**
1	AC-01	TG Building	Chilled Water System	2 Nos x 307 TR WC Chiller (1W +1 S)	2 Nos x 13,47,637 Kcal/hr (1W +1S)	2 Nos x 215 CMH (1W +1S)	2 Nos x 307 CMH (1W +1S)
2	AC-02	ESP-1	DX system with CDU	2 Nos x 30 TR WC CDU (1W +1 S)	2 Nos x 1,31,769 Kcal/hr (1W +1S)	NA	2 Nos x 30 CMH (1W +1S)
3	AC-03	ESP-2	DX system with CDU	2 Nos x 30 TR WC CDU (1W +1 S)	2 Nos x 1,31,769 Kcal/hr (1W +1S)	NA	2 Nos x 30 CMH (1W +1S)
4	AC-04	Service Building	DX system with PAC	20 Nos x 15 TR PAC (10W+10S) 20Nos x 20 TR PAC (10W + 10S)	2 Nos x 15,37,305 Kcal/hr (1W +1S)	NA	2 Nos x 350 CMH (1W +1S)
5	AC-05	Admin Building	DX system with PAC	4Nos x 15 TR PAC (2W + 2S) 12Nos x 20 TR PAC (6W + 6S)	2 Nos x 6,59,450 Kcal/hr.(1W +1S)	NA	2 Nos x 150 CMH (1W +1S)

1. SELECTION OF WATER COOLED CHILLER UNIT FOR AC SYSTEM(AC-1)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design criteria considered**		
1.1	Type of unit	Water cooled	
1.2	Ambient condition	47 degree ^{0}c	As per Tender
1.3	Evaporator type	Flooded type	
2.	Required cooling capacity	307.00 TR	As per heat load calculation(10% higher than actual capacity)
3.	Selected cooling capacity	307.00 TR	
4.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**

2. SELECTION OF CONDENSING UNIT FOR AC SYSTEM(AC-2&3)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design criteria considered**		
1.1	Type of unit	Water cooled	
1.2	Ambient condition	47 degree ^{0}c	As per tender
1.3	Evaporator type	Direct expansion	
2.	Required cooling capacity (Each ESP-1 & ESP-2)	24.00 TR	As per heat load calculation(10% higher than actual capacity)
3.	Selected cooling capacity (Each ESP-1 & ESP-2)	30.00 TR	
4.	**Quantity (2 x 100%) For ESP-1**	**02.00 Nos.**	**[1Working + 1Standby]**
5.	**Quantity (2 x 100%) for ESP-2**	**02.00 Nos.**	**[1Working + 1Standby]**

3. CALCULATION FOR CHILLED WATER PUMP FOR CHILLER (AC-1)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Basic Formulae Used**		
	Q = USGPM X (T_{in} – T_{out})/24		
	Where;		
	Q =Refrigeration Effect In Evaporator	307.00 TR/Hr	From above
	US GPM = Flow Rate Of Chilled Water	To be Calculated	
	T_{in} = Chilled Water Leaving Temperature	44.00° F	Tender Specification
	T_{out} = Chilled Water Entering Temperature	52.00° F	Tender Specification
2	**After putting values in above equations, we get**		
	307 TR = [US GPM x (52.00– 44.00)]/24		
	Hence US GPM = 307 x 24/8 = 921 US GPM	921.00 US GPM (209.31 CMH)	
3.	As per Specification Water flow rate for chilled water pump selection : 0.7 CMH/TR		
	0.7 CMH x 307 TR	214.9 CMH Say 215 CMH (946 USGPM)	
4.	**Selected Capacity of Each Chilled Water Pump**	**215CMH (946 USGPM)**	
5.	**Quantity**	**02.00 Nos.**	**[1Working + 1Standby]**

4. CALCULATION FOR CONDENSER WATER PUMP FOR CHILLER (AC-1)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Basic Formulae Used**		
	Heat Rejection in Condenser = Refrigeration Effect + Motor Power of Compressor		
	Where;		
	Refrigeration Effect In Evaporator (in KW)	307 TR x 3.52 KW/TR = 1080.64 KW	
	Motor Power of Compressor (in KW)	=307*0.8 KW/TR = 245.60 kW	Considered IKW/TR = 0.80
2	**After putting values in above equations, we get**		
2.1	Heat Rejection in Condenser (in KW)	1080.64 + 245.60 = 1326.24 KW	
2.2	Heat Rejection in Condenser (in TR)	1326.24/3.52 KW/TR = 376.77 TR Say 377 TR	
3	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection Required In Condenser	377.00 TR	From Above
	US GPM = Flow Rate Of Chilled Water	To be Calculated	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
	377.0 TR = [US GPM x (96.80 – 89.6)]/24		
	Hence US GPM = 377x 24/7.2 = 1256.66 US GPM	**1256.66 US GPM(285.60 CMH)**	
4.	As per Specification Water flow rate for condenser water pump selection : 1CMH/TR		
	1 CMH x 307 TR	307 CMH (1350.8 USGPM)	
5.	**Selected Capacity of Each Condenser Water Pump**	**1350 US GPM (307CMH)**	
6.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**

5. CALCULATION FOR CONDENSER WATER PUMP FOR WAC PAC (AC-5)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Basic Formulae Used**		
	Heat Rejection in Condenser = Refrigeration Effect + Motor Power of Compressor		

	Where;		
	Refrigeration Effect In Evaporator (in KW)	150 TR x 3.52 KW/TR = 528 KW	Admin Building total load
	Motor Power of Compressor (in KW)	=150*0.9 KW/TR = 135 kW	Considered IKW/TR = 0.90
2	**After putting values in above equations, we get**		
2.1	Heat Rejection in Condenser (in KW)	528 + 135 = 663 KW	
2.2	Heat Rejection in Condenser (in TR)	663/3.52 KW/TR = 188.35 TR	
3	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection Required In Condenser	188.35 TR	From Above
	US GPM = Flow Rate Of Chilled Water	To be Calculated	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
	182.07 TR = [US GPM x (96.80 – 89.6)]/24		
	Hence US GPM = 188.35 X 24/7.2 = 627.8 US GPM	**628 US GPM (143 CMH)**	
4.	As per Specification Water flow rate for condenser water pump selection : 1CMH/TR		
	1 CMH x 150 TR	150 CMH (660 USGPM)	
5.	**Selected Capacity of Each Condenser Water Pump**	**660 US GPM(150 CMH)**	
6.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**

6. CALCULATION FOR CONDENSER WATER PUMP FOR WAC PAC (AC-4)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Basic Formulae Used**		
	Heat Rejection in Condenser = Refrigeration Effect + Motor Power of Compressor		
	Where;		
	Refrigeration Effect In Evaporator (in KW)	350 TR x 3.52 KW/TR = 1232 KW	Service Building total load
	Motor Power of Compressor (in KW)	=350*0.9 KW/TR = 315 kW	Considered IKW/TR = 0.90
2	**After putting values in above equations, we get**		
2.1	Heat Rejection in Condenser (in KW)	1232 + 315 =1547 KW	
2.2	Heat Rejection in Condenser (in TR)	1547/3.52 KW/TR = 439.48 TR	Say 440 TR
3	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		

	Where;		
	Q = Heat Rejection Required In Condenser	440.00 TR	From Above
	US GPM = Flow Rate Of Chilled Water	To be Calculated	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
	427 TR = [US GPM x (96.80 – 89.6)]/24		
	Hence US GPM = 440 x 24/7.2 = 1466.66 US GPM	**1467 US GPM(333.4 CMH)**	
4.	As per Specification Water flow rate for condenser water pump selection : 1 CMH/TR		
	1 CMH x 350 TR	350 CMH (1540 USGPM)	
5.	**Selected Capacity of Each Condenser Water Pump**	**1540 US GPM (350CMH)**	
6.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**

7. CALCULATION FOR CONDENSER WATER PUMP FOR DX SYSTEM (AC-2&3)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Basic Formulae Used**		
	Heat Rejection in Condenser = Refrigeration Effect + Motor Power of Compressor		
	Where;		
	Refrigeration Effect In Evaporator (in KW)	30 TR x 3.52 KW/TR = 105.60 KW	
	Motor Power of Compressor (in KW)	=30*0.9 KW/TR = 27 kW	Considered IKW/TR = 0.90
2	**After putting values in above equations, we get**		
2.1	Heat Rejection in Condenser (in KW)	105.6 + 27 = 132.6 KW	
2.2	Heat Rejection in Condenser (in TR)	132.6/3.52 KW/TR = 38 TR	Selected 38 TR
3	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection Required In Condenser	38 TR	From Above
	US GPM = Flow Rate Of Chilled Water	To be Calculated	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
	38 TR = [US GPM x (96.80 – 89.6)]/24		
	Hence US GPM = 38x 24/7.2 =126.66 US GPM	**127 US GPM(28.86 CMH)**	
4.	As per Specification Water flow rate for condenser water pump selection : 1CMH/TR		

	1 CMH x 30 TR	30 CMH (132 USGPM)	
5.	**Selected Capacity of Each Condenser Water Pump**	**132 US GPM (30 CMH)**	
6.	**Quantity (2 x 100%) for ESP-1**	**02.00 Nos.**	**[1Working + 1Standby]**
7.	**Quantity (2 x 100%) for ESP-2**	**02.00 Nos.**	**[1Working + 1Standby]**

8. CALCULATION FOR COOLING TOWER FOR CHILLER(AC-1)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design Criteria**		
1.1	Design Wet Bulb Temperature	28° C	SUMMER WBT: 27.8 DEG. C MONSOON WBT: 26.7 DEG. C **SELECTED WBT: 28 DEG. C**
1.2	Rated Flow of condenser water pump	1320 US GPM(307 CMH)	From CDW pump Calculation
1.3	Selected Water Flow Quantity of cooling tower	1350*1.1 = 1485 USGPM	110% of rated CDW Pump
1.4	Cooling Tower In/Out Temperature	32° C/36° C	
2	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection	To be Calculated	From Above
	US GPM = Flow Rate Of Chilled Water	1485 US GPM	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
3	**After putting values in above equations, we get**		
3.1	1485 x (96.8-89.6)/24	**445.5TR**	
3.2	**Calculated Heat Rejection Capacity of Cooling Tower in Kcal/hr.**	**445.5 TR x 3025 Kcal/hr/TR**	
		= 13,47,637 Kcal/hr.	
4.	**Selected Capacity of Each Cooling Tower**	**13,47,637 Kcal/hr.**	
5.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**
6.	**Type of the cooling tower**	**Induced draft**	

9. CALCULATION FOR COOLING TOWER FOR WCPAC (AC-5)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design Criteria**		
1.1	Design Wet Bulb Temperature	28° C	SUMMER WBT: 27.8 DEG. C MONSOON WBT: 26.7 DEG. C **SELECTED WBT: 28 DEG. C**
1.2	Total Water Flow Quantity	660 US GPM(150 CMH)	From CDW pump

			Calculation
1.4	Selected Water Flow Quantity of cooling tower	660*1.1 = 726 USGPM	110% of rated CDW Pump
1.3	Cooling Tower In/Out Temperature	32° C/ 36° C	
2	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection	To be Calculated	From Above
	US GPM = Flow Rate Of Chilled Water	726 US GPM	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
3	**After putting values in above equations, we get**		
3.1	726 x (96.8-89.6)/24	**218 TR**	
3.2	**Calculated Heat Rejection Capacity of Cooling Tower in Kcal/hr.**	**218 TR x 3025 Kcal/hr/TR**	
		= 6,59,450 Kcal/hr.	
4.	**Selected Capacity of Each Cooling Tower**	**6,59,450 Kcal/hr.**	
5.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**
6.	**Type of the cooling tower**	**Induced draft**	

10.CALCULATION FOR COOLING TOWER FOR WCPAC (AC-4)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design Criteria**		
1.1	Design Wet Bulb Temperature	28° C	SUMMER WBT: 27.8 DEG. C MONSOON WBT: 26.7 DEG. C **SELECTED WBT: 28 DEG. C**
1.2	Total Water Flow Quantity	1540 USGPM (350 CMH)	From CDW pump Calculation
1.3	Selected Water Flow Quantity of cooling tower	1540*1.1 = 1694 USGPM	110% of rated CDW Pump
1.4	Cooling Tower In/Out Temperature	32° C/36° C	
2	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection	To be Calculated	From Above
	US GPM = Flow Rate Of Chilled Water	1694 US GPM	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
3	**After putting values in above equations, we get**		
3.1	1694 x (96.8-89.6)/24	**508.2 TR**	

3.2	**Calculated Heat Rejection Capacity of Cooling Tower in Kcal/hr.**	**508.2 TR x 3025 Kcal/hr/TR**	
		= 15,37,305 Kcal/hr.	
4.	**Selected Capacity of Each Cooling Tower**	**15,37,305 Kcal/hr.**	
5.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**
6.	**Type of the cooling tower**	**Induced draft**	

11.CALCULATION FOR COOLING TOWER FOR WCPAC (AC-2&3)

S.NO.	DESCRIPTION	DATA	REFERENCE
1	**Design Criteria**		
1.1	Design Wet Bulb Temperature	28° C	SUMMER WBT: 27.8 DEG. C MONSOON WBT: 26.7 DEG. C **SELECTED WBT: 28 DEG. C**
1.2	Total Water Flow Quantity	132 US GPM (30 CMH)	From CDW pump Calculation
1.3	Selected Water Flow Quantity of cooling tower	132*1.1 = 145.2 USGPM	110% of rated CDW Pump
1.4	Cooling Tower In/Out Temperature	32° C/36° C	
2	Now We know; **Q = USGPM X (T_{in} – T_{out})/24**		
	Where;		
	Q = Heat Rejection	To be Calculated	From Above
	US GPM = Flow Rate Of Chilled Water	145.2 US GPM	
	T_{in} = Condenser Water Leaving Temperature	36° C (96.80° F)	
	T_{out} = Condenser Water Entering Temperature	32° C (89.6° F)	
3	**After putting values in above equations, we get**		
3.1	145.2 x (96.8-89.6)/24	**43.56 TR**	
3.2	**Calculated Heat Rejection Capacity of Cooling Tower in Kcal/hr.**	**43.56 TR x 3025 Kcal/hr/TR**	
		= 1,31,769 Kcal/hr.	
4.	**Selected Capacity of Each Cooling Tower**	**1,31,769 Kcal/hr.**	
5.	**Quantity (2 x 100%)**	**02.00 Nos.**	**[1Working + 1Standby]**
6.	**For ESP-1**	**02.00 Nos.**	**[1Working + 1Standby]**
7.	**For ESP-1**	**02.00 Nos.**	**[1Working + 1Standby]**

12. SELECTION FOR AIR HANDLING UNIT & WC PAC UNIT

S.No	Location	AHU/PAC Capacity		Quantity	Type of AHU
		Air Quantity	Cooling Cap.		
1.	**POWER HOUSE BUILDING(AC-01)**				
1.1	AHU Room, EL. 24.0 m LVL	54200CFM	111.00 TR	04.00 Nos. [2W + 2S]	FM AHU (CHW TYPE)
1.2	AHU Room, EL. 8.50 m LVL	31700 CFM	60.00 TR	02.00 Nos. [1W + 1S]	FM AHU (CHW TYPE)
1.3	SWAS Room- UN-01, EL. 0.00 m LVL	1200 CFM	3.0 TR	03.00 Nos. [3W + 0S]	C.S.F.C.U (CHW TYPE)
1.4	SWAS Room- UN-02, EL. 0.00 m LVL	1200 CFM	3.0 TR	03.00 Nos. [3W + 0S]	C.S.F.C.U (CHW TYPE)
2.	**SERVICE BUILDING(AC-04)**				
2.1	PAC Room, EL. 00.0 m LVL	6000 CFM 8000 CFM	15.00 TR 20.00 TR	04.00 Nos. [2W + 2S] 04.00 Nos. [2W + 2S]	WCPAC
2.2	PAC Room, EL. 04.25 m LVL	6000 CFM	15.00 TR	08.00 Nos (4W + 4S)	WCPAC
2.3	PAC Room, EL. 08.5 m LVL	6000 CFM 8000 CFM	15.00 TR 20.00 TR	04.00 Nos. [2W + 2S] 04.00 Nos. [2W + 2S]	WCPAC
2.4	PAC Room, EL. 12.75 m LVL	6000 CFM 8000 CFM	15.00 TR 20.00 TR	04.00 Nos. [2W + 2S] 04.00 Nos. [2W + 2S]	WCPAC
2.5	PAC Room, EL. 17.0 m LVL	8000 CFM	20.00 TR	08.00 Nos (4W + 4S)	WCPAC
3.	**ADMIN BUILDING(AC-05)**				
3.1	PAC Room, EL. 00.0 m LVL	6000 CFM 8000 CFM	15.00 TR 20.00 TR	04.00 Nos. [2W + 2S] 04.00 Nos. [2W + 2S]	WCPAC
3.2	PAC Room, EL. 4.5 m LVL	8000 CFM	20.00 TR	08.00 Nos. [4W + 4S]]	WCPAC
4.	**ESP-1 BUILDING(AC-02)**				
4.1	AHU Room	10000 CFM	30 TR	02.00 Nos. [1W + 1S]	FM AHU (DX TYPE)
5.	**ESP-1 BUILDING(AC-03)**				
5.1	AHU Room	10000 CFM	30 TR	02.00 Nos. [1W + 1S]	FM AHU (DX TYPE)

REFERENCE-HEAT LOAD CALCULATION

FM AHU : Floor Mounted Air Handling Unit

WC PAC : Water Cooled Package Air Conditioner

13. SELECTION FOR STRIP HEATER

S.No.	Location	Heater Capacity	No. of Banks	Quantity	Type of Heater
1.	**POWER HOUSE BUILDING(AC-01)**				
1.1	AHU Room, EL. 24.0 m LVL	221.00 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
1.2	AHU Room, EL. 8.50 m LVL	48 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
1.3	SWAS Room- UN-01, EL. 0.00 m LVL	9 KW	1 Nos	03.00 Nos. [W]	Duct Mounted
1.4	SWAS Room- UN-02, EL. 0.00 m LVL	9 KW	1 Nos	03.00 Nos. [W]	Duct Mounted
2.	**SERVICE BUILDING(AC-04)**				
2.1	PAC Room-1, EL. 00.0 m LVL	16 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.2	PAC Room-2, EL. 00.0 m LVL	11 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.3	PAC Room, EL. 04.25 m LVL	17 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.3	PAC Room, EL. 04.25 m LVL	21 KW	4 Nos	01.00 Nos. [W]	Duct Mounted
2.4	PAC Room, EL. 08.5 m LVL	15 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.4	PAC Room, EL. 08.5 m LVL	21 KW	4 Nos	01.00 Nos. [W]	Duct Mounted
2.5	PAC Room, EL. 12.75 m LVL	16KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.5	PAC Room, EL. 12.75 m LVL	24 KW	4 Nos	01.00 Nos. [W]	Duct Mounted
2.6	PAC Room-1, EL. 17.0 m LVL	10 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
2.7	PAC Room-2, EL. 17.0 m LVL	15 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
3.	**ADMIN BUILDING(AC-05)**				
3.1	PAC Room -1 , EL. 00.0 m LVL	11.00 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
3.2	PAC Room - 2 , EL. 00.0 m LVL	16.00 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
3.3	PAC Room - 3 , EL. 4.5 m LVL	13.00 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
3.4	PAC Room - 4 , EL. 4.5 m LVL	21.00 KW	3 Nos	01.00 Nos. [W]	Duct Mounted
4.	**ESP-1 BUILDING(AC-02)**				
4.1	AHU Room	18 KW	3 Nos	01.00 Nos. [W]	Duct Mounted

5.	**ESP-2 BUILDING(AC-03)**				
5.1	AHU Room	18 KW	3 Nos	01.00 Nos. [W]	Duct Mounted

REFERENCE-HEAT LOAD CALCULATION

14. SELECTION FOR HUMIDIFIER

S.No.	Location	Humidifier Capacity	Quantity	Type of Heater
1.	**POWER HOUSE BUILDING(AC-01)**			
1.1	AHU Room, EL. 24.0 m LVL	1.5 KW	01.00 Nos. [W]	PAN TYPE
1.2	AHU Room, EL. 8.50 m LVL	1.5 KW	01.00 Nos. [W]	PAN TYPE
2.	**SERVICE BUILDING(AC-04)**			
2.1	PAC Room, EL. 00.0 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
2.2	PAC Room, EL. 04.25 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
2.3	PAC Room, EL. 08.5 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
2.4	PAC Room, EL. 12.75 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
2.5	PAC Room, EL. 17.0 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
3.	**ADMIN BUILDING(AC-05)**			
3.1	PAC Room, EL. 00.0 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
3.3	PAC Room, EL. 4.5 m LVL	1.5 KW	02.00 Nos. [2W]	PAN TYPE
4.	**ESP-1 BUILDING(AC-02)**			
4.1	AHU Room	1.50 KW	01.00 Nos. [W]	PAN TYPE
5.	**ESP-2 BUILDING(AC-03)**			
5.1	AHU Room	1.50 KW	01.00 Nos. [W]	PAN TYPE

16. CALCULATION FOR FRESH AIR

S.No.	Location	Calculated Capacity (CFM)	Fan Capacity (CFM)	Quantity	Construction of Fresh Air Unit			
					Type of Fan	Pre-Filter	Fine-Filter	VCD
1.	**POWER HOUSE BUILDING(AC-01)**							
1.1	AHU Room, EL. 24.0 m LVL	6029	3000	02.00 No. [2W]	Axial	Yes	Yes	Yes
1.2	AHU Room, EL. 8.50 m LVL	964	500	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.	**SERVICE BUILDING(AC-04)**							
2.1	PAC Room, EL. 00.0 m LVL	1715	900	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.2	PAC Room, EL. 00.0 m LVL	799	400	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.3	PAC Room, EL. 04.25 m LVL	1239	600	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.4	PAC Room, EL. 04.25 m LVL	950	500	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.5	PAC Room, EL. 08.5 m LVL	1139	600	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.6	PAC Room, EL. 08.5 m LVL	1120	600	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.7	PAC Room, EL. 12.75 m LVL	1139	600	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.8	PAC Room, EL. 12.75 m LVL	1420	700	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.9	PAC Room, EL. 17.0 m LVL	1368	700	02.00 No. [2W]	Axial	Yes	Yes	Yes
2.10	PAC Room, EL. 17.0 m LVL	1320	650	02.00 No. [2W]	Axial	Yes	Yes	Yes
3.	**ADMIN BUILDING(AC-05)**							
3.1	PAC Room -1 , EL. 00.0 m LVL	1031	500	02.00 No. [2W]	Axial	Yes	Yes	Yes
3.2	PAC Room - 2 , EL. 00.0 m LVL	1669	850	02.00 No. [2W]	Axial	Yes	Yes	Yes
3.3	PAC Room - 3 , EL. 4.5 m LVL	1800	900	02.00 No. [2W]	Axial	Yes	Yes	Yes
3.4	PAC Room - 4 , EL. 4.5 m LVL	1774	900	02.00 No. [2W]	Axial	Yes	Yes	Yes
4.	**ESP-1 BUILDING(AC-02)**							
4.1	AHU Room	465	250	02.00 No. [2W]	Axial	Yes	Yes	Yes
5.	**ESP-2 BUILDING(AC-03)**							
5.1	AHU Room	465	250	02.00 No. [2W]	Axial	Yes	Yes	Yes

Notes:

- FOR CHILLER, AHU, PAC, HUMIDIHIER & HEATER CAPACITY, PLEASE REFER HEAT LOAD CALCULATION ATTACHED.
- FOR CHILLER CAPACITY, WE HAVE SELECTED 10% HIGHER THAN ACTUAL CAPACITY.
- FOR AHU CAPACITY, WE HAVE SELECTED 10% HIGHER THAN ACTUAL CAPACITY.
- WE HAVE CONSIDERED INSULATED EXPOSED ROOF (UNDERDECK INSULATION) WHEREEVER APPLICABLE IN OUR HEAT LOAD CALCULATION
- SWAS ROOM AIR CONDITIONING IS DONE THROUGH FCU FOR WHICH NO FRESH AIR FAN IS ENVISAGED AS FRESH AIR REQUIREMENT IS NEGLIGIBLE AND CAN BE MET BY OPENING AND CLOSING OF DOORS.

BASIS OF HEAT LOAD CALCULATION

1. Basic Consideration

Project	: 2X660 MW SUPER-CRITICAL THERMAL POWER PLANTS, ENNORE
Location	: Near Vill-Vayalur, Dist-Ennore, Tamilnadu (India)
Latitude	: $13^0$17'N
Elevation above Sea Level	: (+) 0Meters
Occupancy	: The occupancy is as per furniture layout. If it is not available then as per tender specification as below: General area shall be minimum one person per 3 m² and for conference room the same shall be one per 1.5 m². In the control rooms, control equipment rooms etc. the occupancy shall be consideredone person per 20 m² (minimum).
Lighting Load	: 2 Watt/ Sqft .
Equipment Load	: As per Electrical load list furnished by BHEL. If it is not available the same is considered as per Equipment layout and application of area.
Fresh Air	: 1.5 ACPH (Min) OR 35m^3/hr (20 CFM) Per Person, Whicheverishigher.
Wall Construction	: Inside and Outside Wall thickness-230 mm thick brick with 12 mmthick Plaster on both side.
Floor & Slab Construction	: 150 MM thick RCC Slab with 12mmthick plasters both side. 50mm Underdeck insulation for exposed roof.
False Ceiling Construction	: 50 MM thick Gypsum Board Plaster.

2. Outside Design Conditions

Based on outside design data specified in ISHRAE Table 1, the outdoor design conditions for Chennai (data available nearest to Ennore) have been considered as follows:

Summer	: Dry Bulb Temperature	47 deg C (116.4 deg F)
	: Wet Bulb Temperature	27.77 deg C (82 deg F)
	: Humidity Ratio	110 grain/lb
Monsoon	: Dry Bulb Temperature	28.33 deg C (83 deg F)
	: Wet Bulb Temperature	26.66 deg C (80 deg F)
	: Relative Humidity	88%
	: Humidity Ratio	151.40 grain/lb
Winter	: Dry Bulb Temperature	18.30 deg C (65.00 deg F)
	: Wet Bulb Temperature	13.90 deg C (57.00 deg F)
	: Relative Humidity	61.80%
	: Humidity Ratio	56.70 grain/lb

3. Inside Design Conditions

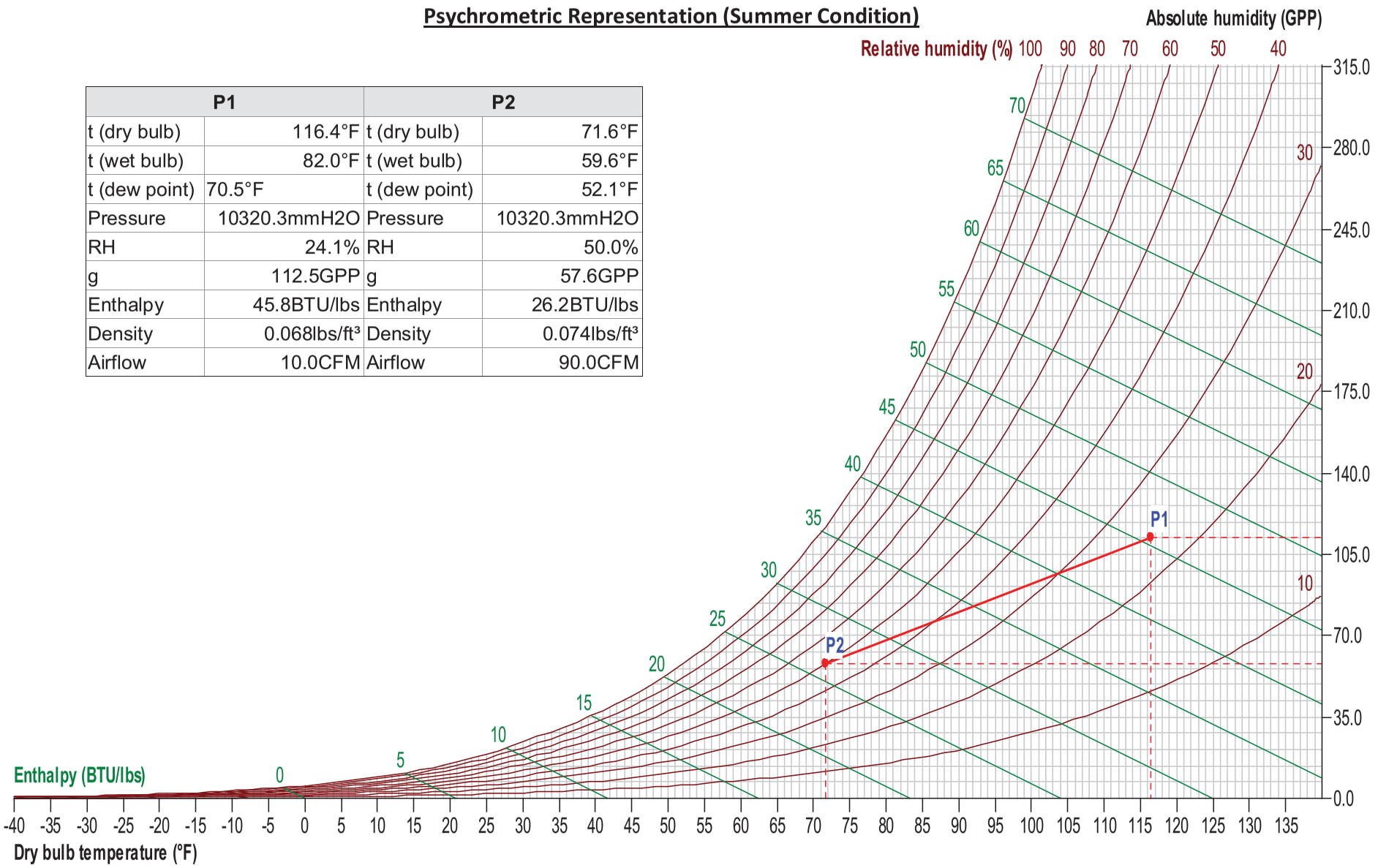
Based on Insidedesign data specified in Technical Specification for Air Conditioning System, the inside design conditions for Air Conditioned Area have been considered as follows:

Summer/Monsoon/Winter	: Dry Bulb Temperature	22±1 deg C (71.60 deg F)
(Power house CCR, UPS Control Room	: Wet Bulb Temperature	15.41 deg C (59.75 deg F)
and ESP control Room)	: Relative Humidity	50±5%
	: Humidity Ratio	57.80 grain/lb
Summer/Monsoon/Winter	: Dry Bulb Temperature	24±1 deg C (75.20 deg F)
(Comfort Cooling for Admin and	: Wet Bulb Temperature	17 deg C (62.7 deg F)
and service building)	: Relative Humidity	50±5%
	: Humidity Ratio	65.4 grain/lb

Note: With design inside condition of 22 deg. C & 50 % RH, apparatus dew point is arriving at 50 deg. F. Package type air conditioner is standard product and available ADP is 52 deg. F. considering above, inside design parameters of 22 deg. C & 50 % RH is not feasible. Hence, inside ambient of 24 deg. C with 50% RH (meant for comfort cooling) shall be maintained inside administration and service building. For equipment sizing design inside temperature is considered as 22 deg. C & 50 % RH.

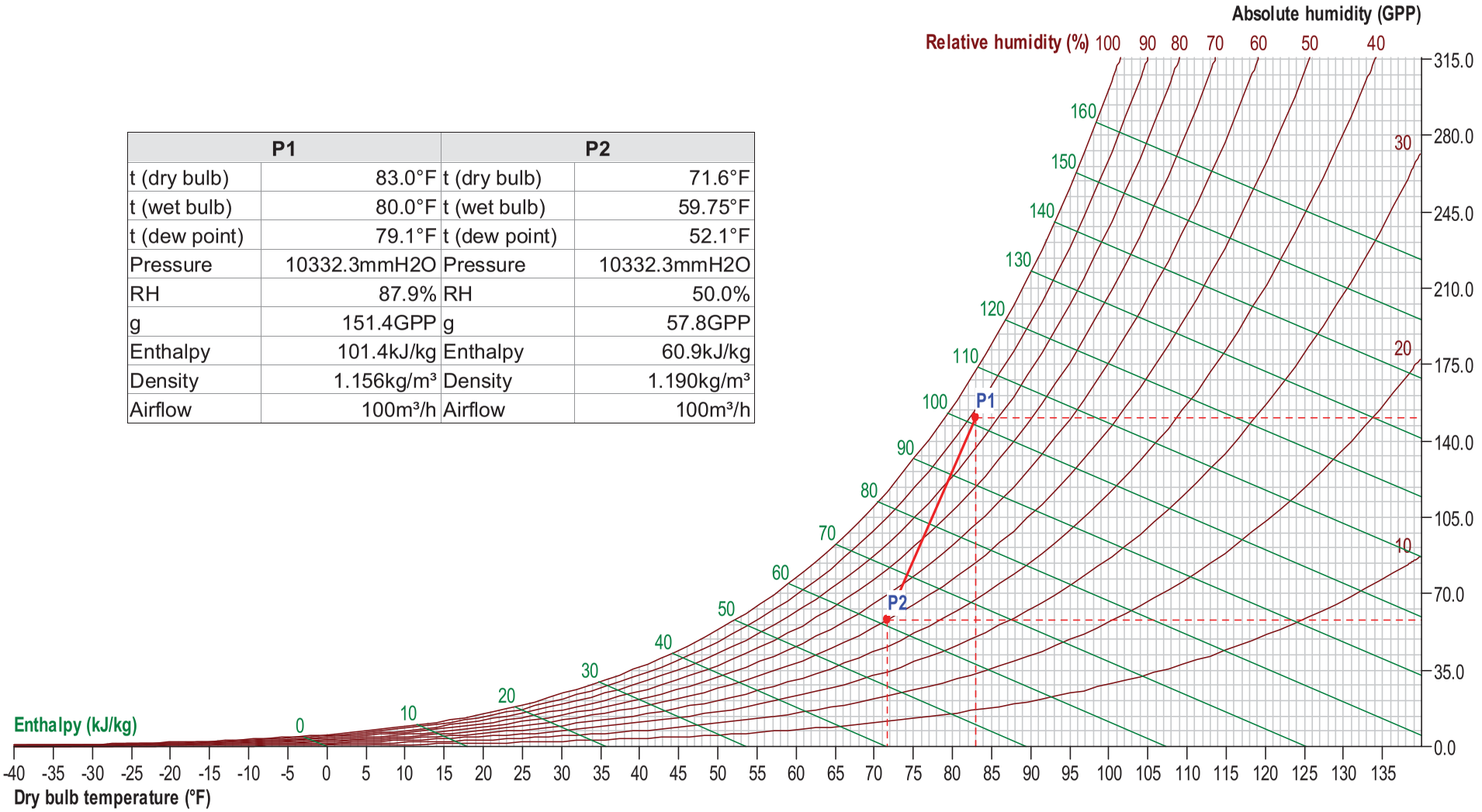
Psychrometric Representation (Summer Condition)

P1		P2	
t (dry bulb)	116.4°F	t (dry bulb)	71.6°F
t (wet bulb)	82.0°F	t (wet bulb)	59.6°F
t (dew point)	70.5°F	t (dew point)	52.1°F
Pressure	10320.3mmH2O	Pressure	10320.3mmH2O
RH	24.1%	RH	50.0%
g	112.5GPP	g	57.6GPP
Enthalpy	45.8BTU/lbs	Enthalpy	26.2BTU/lbs
Density	0.068lbs/ft³	Density	0.074lbs/ft³
Airflow	10.0CFM	Airflow	90.0CFM



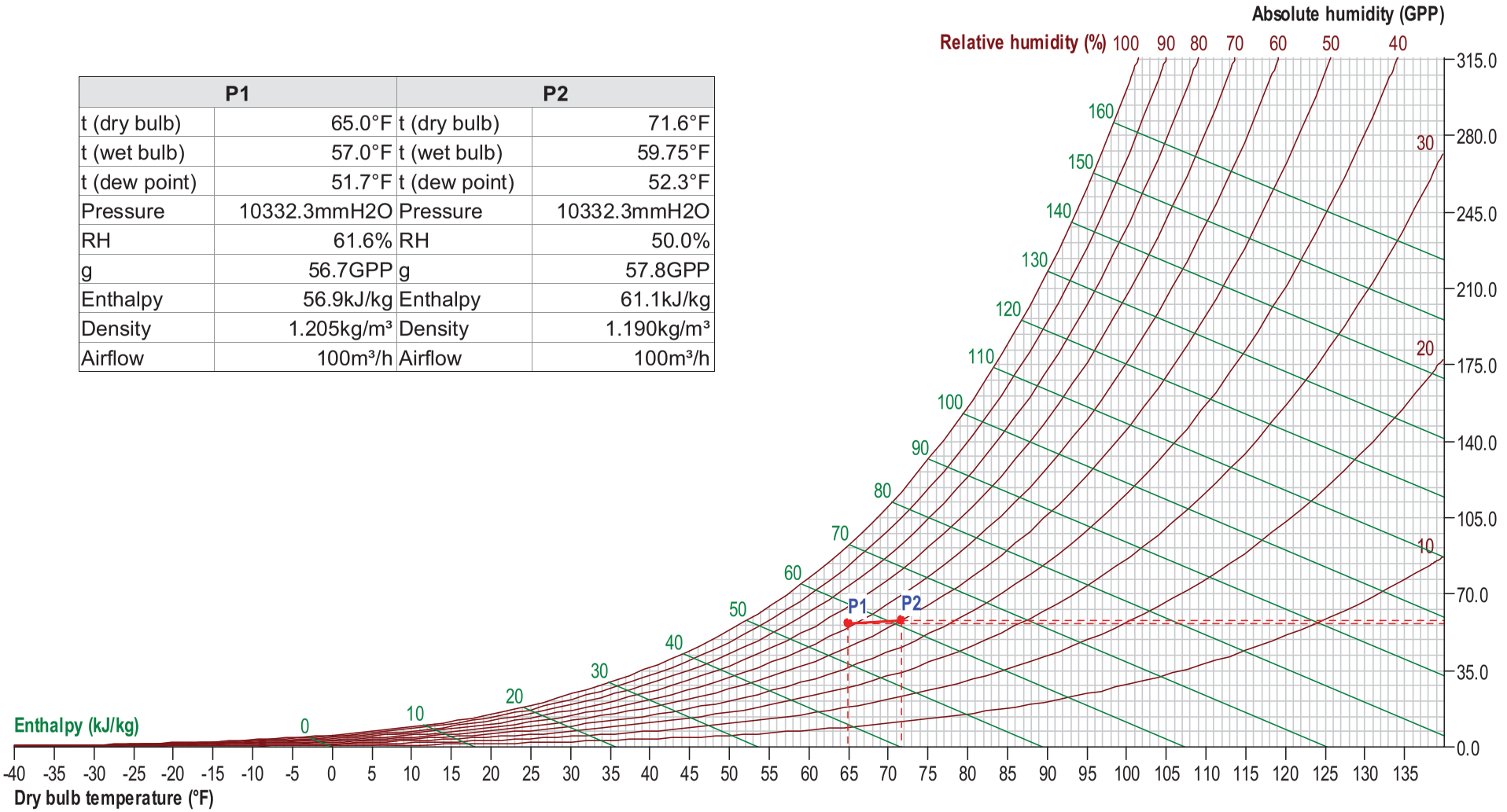
Psychrometric Representation (Monsoon Condition)

P1		P2	
t (dry bulb)	83.0°F	t (dry bulb)	71.6°F
t (wet bulb)	80.0°F	t (wet bulb)	59.75°F
t (dew point)	79.1°F	t (dew point)	52.1°F
Pressure	10332.3mmH2O	Pressure	10332.3mmH2O
RH	87.9%	RH	50.0%
g	151.4GPP	g	57.8GPP
Enthalpy	101.4kJ/kg	Enthalpy	60.9kJ/kg
Density	1.156kg/m³	Density	1.190kg/m³
Airflow	100m³/h	Airflow	100m³/h



Psychrometric Representation (Winter Condition)

P1		P2	
t (dry bulb)	65.0°F	t (dry bulb)	71.6°F
t (wet bulb)	57.0°F	t (wet bulb)	59.75°F
t (dew point)	51.7°F	t (dew point)	52.3°F
Pressure	10332.3mmH2O	Pressure	10332.3mmH2O
RH	61.6%	RH	50.0%
g	56.7GPP	g	57.8GPP
Enthalpy	56.9kJ/kg	Enthalpy	61.1kJ/kg
Density	1.205kg/m³	Density	1.190kg/m³
Airflow	100m³/h	Airflow	100m³/h



4. **Sun Gain thru Glass at 10^0N Latitude at peak Load [Ref Attached ISHRAE Handbook, Table No-07, Page No-1.10].**
   a) For Summer- July 23 & May 21 at 4:00 pm
   b) For Monsoon-August 24 & April 20 at 4:00 pm
   c) For Winter-Nov 21 & Jan 21 at 6:00 am

S.NO.	DESCRIPTION	T	
		SUMMER	MONSOON
1	North	39	16
2	South	11	11
3	East	11	11
4	West	158	163
5	North East	11	11
6	North West	148	130
7	South East	11	11
8	South West	66	94
9	Horizontal	107	105

T = Temperature Difference from ISHRAE **Handbook, Table-7, Page-1.10** (Solar Heat Gain Thru Ordinary Glass with Wooden Frame Corresponding to 10º N Latitude for desired Month, Time & Exposure.

5. **Over all Factor for solar heat gain through glass =0.6**as per Tender Specification(provided by BHEL

6. **Solar & Transmission Gain** thru Exposed walls & Roof at weight of wall is 100lb/sqft and weight of roof is 60lb/sqft. [Ref Attached ISHRAE Handbook Table No-09]

a) Temperature Difference between Outside & Inside

For Summer- (+) 45 °F

For Monsoon- (+) 11.40°F

For Winter- (-) 6.60°F

b) Daily Range for Chennai [Ref Attached ISHRAE Handbook, Table No-01, Page-1.2OR Used Formulae from Carrier Handbook, Ch-05 Page No-63]For summer, Monsoon & Winter-**18 deg F**

c) Daily Range and Design Temperature Difference Correction Factorfor Equivalent Temperature [Ref Attached ISHRAE Handbook, Table No-11, Page-1.16OR Used Formulae from Carrier Handbook, Ch-05 Page No-63]

For Summer-(+) 30.8 deg F

For Monsoon-(-) 2.6 deg F

7. **U-Value** considered as per tender (provided by BHEL)

8. **All Glass Transmission Coefficient** of U factor=1.13 for Single Pan Ordinary Glass, without storm [Ref Attached ISHRAE Handbook, Table No 06, Page-1.8]
9. **Bypass factor** for 4 Row Cooling coil at 12 FPI and 500 FPM Air Velocity=0.10 [Ref Attached ISHRAE Handbook Table No-13 & 14, Page No-1.17]
10. **Indicated ADP** is selected from ISHRAE Handbook, Table-15 and Selected Apparatus Dew Point is 52 Deg F for Chilled Water System and 52 Deg F for DX system.
11. **Heat Gain from occupant** as per ISHRAE Table-12
12. **Safety Factor** considered as per tender as below**:**

    Sensible Load – 12.5%, Latent Load – 10%, Overall Heat Load – 10%
13. **Design Margin** for selection of Equipment – 10% as per tender.

I) INPUT DATA — **2X660 MW ENNORE TPS**

1) Areas to be air-conditioned: Doc No: PE-V0-412-553-A011 Rev 00

Location: Chennai (Tamil Nadu)

2) Outdoor Design Condition

	Summer	Monsoon	Winter
DBT	116.6°F	83.0°F	65.0°F
WBT	82.0°F	80.1°F	57.0°F
RH	41 %	88 %	60 %
Daily Range -	18.0°F		
Altitude-	16 Mts.		
Latitude -	13.04		

3) Inside Design Condition

DBT,°C	% RH	DBT,°F	% RH
22 ± 1	50 ± 5	71.6	50

A) HEAT TRANSFER CO-EFFICIENT (U)

1 **Partition Wall - 115mm thick brick with 12mm thick plaster on both sid**

Element	R, Hr °Fft²/BTU	
115mm thk brickwall R=0.2/in	0.92	ISHRAE - 2014, Table 1, T20, Page no. 1.21, Under masonary Units
12mm thk plaster R=0.2/in for Both Sides	0.189	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
External air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
Total	2.469	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.41**	

2 **Outer Walls - 230 mm Thick brick with 12mm thick plaster on both side**

Element	R, Hr °Fft²/BTU	
230mm thk brickwall R=0.2/in	1.84	ISHRAE - 2014, Table 1, T20, Page no. 1.21, Under masonary Units
12mm thk plaster R=0.2/in for Inside	0.094	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
12mm thk plaster R=0.2/in for Outside	0.094	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
External air film	0.25	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Summer 71/2 MPH
Total	2.958	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.34**	

3 **Roof (Exposed to Sun) with Insulation**

Element	R, Hr °Fft²/BTU	
150mm thk RCC=0.20/in	1.181	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Masonary material, Cement Mortar
20 mm thk plaster R=0.2/in for Both Sides	0.315	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
External air film	0.25	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Summer 71/2 MPH
50mm Insulation = 3.33/in	6.56	ISHRAE - 2014, Table 1-T-20, Page no. 1.23, material - Loose Fill, Mineral Wool (Glass, Slag or Rock)
Total	8.981	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.11**	

4 **Roof (Not Exposed to Sun) without Insulation**

Element	R, Hr °Fft²/BTU	
150mm thk RCC=0.20/in	1.181	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Masonary material, Cement Mortar
40mm thk plaster R=0.2/in on Floor Side	0.315	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
10mm thk Ceramic Tile, R=0.08	0.08	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Flooring material. Ceramic Tile
Internal air film	0.61	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
Internal air film	0.61	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Summer 71/2 MPH
Total	2.716	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.37**	

4 **Floor without Insulation**

Element	R, Hr °Fft²/BTU	
150mm thk RCC=0.20/in	1.181	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Masonary material, Cement Mortar
40mm thk plaster R=0.2/in on Floor Side	0.315	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
10mm thk Ceramic Tile, R=0.08	0.08	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Flooring material. Ceramic Tile
Internal air film	0.61	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
Internal air film	0.61	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Summer 71/2 MPH
Total	2.716	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.37**	

5 **Floor with Insulation**

Element	R, Hr °Fft²/BTU	
150mm thk RCC=0.20/in	1.181	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Masonary material, Cement Mortar
40mm thk plaster R=0.2/in on Floor Side	0.315	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
40mm thk Ceramic Tile, R=0.08	0.08	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Flooring material. Ceramic Tile
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
25mm Insulation = 2.5/in	2.5	ISHRAE - 2014, Table 6, T6, Page no. 6.5, material - Fibreglass Rigid Panel
Total	5.356	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.19**	

6 **AHU / AC Package Room Walls - 230 mm Thick brick with 12mm thick plaster on both side, Insulate**

Element	R, Hr °Fft²/BTU	
230mm thk brickwall R=0.2/in	1.84	ISHRAE - 2014, Table 1, T20, Page no. 1.21, Under masonary Units
12mm thk plaster R=0.2/in for Inside	0.094	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
12mm thk plaster R=0.2/in for Outside	0.094	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
Internal air film	0.68	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Still Air
25mm Insulation = 3.33/in	3.33	ISHRAE - 2014, Table 1-T-20, Page no. 1.23, material - Loose Fill, Mineral Wool (Glass, Slag or Rock)
Total	6.718	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.15**	

7 **AHU / AC Package Room Roof - Acoustic Insulated**

Element	R, Hr °Fft²/BTU	
150mm thk RCC=0.20/in	1.181	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Masonary material, Cement Mortar
20 mm thk plaster R=0.2/in for Both Sides	0.315	ISHRAE - 2014, Table 1, T20, Page no. 1.22, Under Plastering Material, Cement Plaster
Internal air film (Horizontal)	0.62	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film - Horizontal, Still Air
External air film (Horizontal)	0.92	ISHRAE - 1997, Table 8, Page no. 1.13, Under Air Film, Summer 71/2 MPH
25mm Insulation = 3.33/in	3.28	ISHRAE - 2014, Table 1-T-20, Page no. 1.23, material - Loose Fill, Mineral Wool (Glass, Slag or Rock)
Total	6.314	
Overall heat transfer coefficient U=1/R, BTU/hr°Fft²	**0.16**	

8	Ordinary Glass w/o storm window	**1.13**	BTU/hr°Fft²	ISHRAE - 2014, Table 1, T9, Page no. 1.13, Without Storm Window, Single
9	Double Pane Glass w/o storm window	**0.55**	BTU/hr°Fft²	ISHRAE - 2014, Table 1, T9, Page no. 1.13, Double Pane with 12mm Air Gap
10	Overall factor for solar heat gain through Ordinary glass	**0.56**		ISHRAE - 2014, Table 1, T8, Page no. 1.13, Ordinary Glass Light Color
11	Overall factor for solar heat gain through double Pane, regular Plat	**0.52**		ISHRAE - 2014, Table 1, T8, Page no. 1.13, Regular Plate, Double Pane, Light Color
12	False Ceiling / Partition/ Ceiling	**0.41**	BTU/hr°Fft²	

B) CALCULATION OF FRESH AIR REQUIREMENT

1	For control /CER room	1.5	ACPH or 20 CFM/Person(0.45cm/min/person) whichever is higher
2	For Service building	1.5	ACPH or 20 CFM/Person(0.45cm/min/person) whichever is higher

C) BYPASS FACTOR

1 Bypass Factor- 0.12

Input Data

PROJECT : 2x660 MW ENNORE STPP

SUBJECT : ESTIMATED HEAT LOAD CALCULATION SUMMARY SHEET FOR POWER HOUSE BUILDINGS

S.No.	Name of Area	Design Conditions		Floor Area	Occupancy	Lighting Load	Equipment Load	Calculated							Selected					Capacity		Qty.
								Summer Cooling	Monson Cooling	Winter	Reheat	Humdification	Fresh Air	Deh. Air	Selected Capacity WITH 10% SAFETY		Humidifer (Capacity)	Heater (Capacity)	Type of Equipment			
		DB	RH																			
		(Deg C)	(%)	(Sq.ft)	(Nos.)	(Watt)	(Watt)	(TR)	(TR)	KW	KW	KW	(CFM)	(CFM)	(TR)	CFM	(KW)	(KW)		TR.	CFM	NOS
	POWER HOUSE-17.00 LVEL																					
1	CCR -17M	22±1	50±5	4842.00	23	9684	25000	48.37	28.01	11.47	-51.00	-0.32	1429	20724	53.20	22797	1.5	221.1	F.M. A.H.U (CHW TYPE)	110.5	54119	2 (W)+ 2(S)
2	CER -UNIT 01-SMALL-17M			1722.00	8	3444	20000	16.55	12.82	10.83	-11.00	-0.11	508	8354	18.21	9190						
3	A/C ROOM-UNIT 01-17M			813.00	4	1626	8000	8.00	5.65	4.65	-7.00	-0.05	240	4066	8.80	4472						
4	A/C ROOM-UNIT 02-17M			813.00	4	1626	8000	8.00	5.65	4.65	-7.00	-0.05	240	4066	8.80	4472						
5	CER -UNIT 02-SMALL-17M			1912.00	9	3824	20000	19.63	14.10	10.96	-20.00	-0.13	564	10753	21.60	11828						
6	CER -UNIT 01-BIG-17M			3828.00	18	7656	40000	39.69	27.54	20.65	-41.00	-0.25	1130	21119	43.65	23231						
7	CER -UNIT 02-BIG-17M			3828.00	18	7656	40000	40.21	28.17	22.12	-41.00	-0.25	1130	21465	44.23	23611						
8	STATION INCHARGE ROOM-17M			204.00	6	408	360	2.44	1.58	0.06	-3.00	-0.03	126	928	2.69	1020						
9	BMS ROOM -UN-01-17M			69.00	2	138	360	0.79	0.58	0.19	-1.00	-0.01	40	307	0.87	338						
10	BMS ROOM -UN-02-17M			53.00	2	106	360	1.21	0.65	0.08	-2.00	-0.01	40	577	1.33	635						
11	SERVER ROOM-17 M			160.00	5	320	580	2.35	1.41	0.18	-3.00	-0.02	100	1005	2.58	1105						
12	C&I ENG ROOM-17 M			160.00	5	320	360	1.86	1.26	0.11	-2.00	-0.02	100	685	2.04	754						
13	PADO ROOM -UN-01-17M			150.00	5	300	640	2.04	1.40	0.14	-2.00	-0.02	100	802	2.24	883						
14	PADO ROOM -UN-02-17M			150.00	5	300	640	2.93	1.61	-0.08	-4.00	-0.02	100	1391	3.23	1530						
15	DINING ROOM & PANTRY -17M			228.00	14	456	1000	4.81	3.34	0.06	-4.00	-0.06	100	1391	5.29	1530						
16	EDMS ROOM -UN-01-17M			73.00	2	146	320	1.02	0.64	0.02	-1.00	-0.01	40.00	458	1.13	503						
17	EDMS ROOM -UN-02-17M			73.00	2	146	320	0.80	0.57	0.16	-1.00	-0.01	40.00	308	0.87	339						
	SUB TOTAL-01			**19078.00**	**132.00**	**38156.00**	**165940.00**	**201.00**	**135.00**	**86.00**	**-201.00**	**-1.00**	**6029.00**	**98398.00**	**221.00**	**108238.00**						
	POWER HOUSE-8.50 LVEL																					
18	UPS & BATTERY CHRGR ROOM-8.5 M	22±1	50±5	3675.00	17	7350	70000	53.33	37.60	37.44	-44.00	-0.21	964	28790	58.66	31669	1.5 kw	48.4	F.M. A.H.U (CHW TYPE)	58.66	31669	(1W)+1(S)
	SUB TOTAL -02			**3675.00**	**17.00**	**7350.00**	**70000.00**	**53.33**	**37.60**	**37.44**	**-44.00**	**-0.21**	**964.32**	**28789.84**	**58.66**	**31669.00**						
	POWER HOUSE-0.00 LEVEL																					
19	SWAS RM-UN-01-00 M	22±1	50±5	688.00	3	1376	3500	6.64	3.93	0.86	-8.00	0.00	226	3251	7.31	3576	NA	8.8	C.S F.C.U	3	1200	3(W)
20	SWAS RM-UN-02-00 M	22±1	50±5	688.00	3	1376	3500	6.74	4.02	1.20	-8.00	0.00	226	3315	7.41	3646	NA	8.8	C.S F.C.U	3	1200	3(W)
	SUBT TOTAL -04			**1376.00**	**6.00**	**2752.00**	**7000.00**	**13.38**	**7.95**	**2.06**	**-16.00**	**0.00**	**451.33**	**6565.63**	**14.72**	**7222.00**						
	GRAND TOTAL FOR CHW SYSTEM			**24129.00**	**155.00**	**48258.00**	**242940.00**	**267.71**	**180.55**	**125.50**	**-261.00**	**-1.21**	**7444.65**	**133753**	**294.38**	**147129.00**			**W.C. SCREW CHILLER**	**307 TR**	**NA**	**2(1 W+1S)**
	F.M. A.H.U -			FLOOR MOUNTED AIR HANDLING UNIT																		
	C.S F.C.U -			CEILING SUSPENDED FAN COOLING UNIT																		
	W+S -			WORKING +STAND BY																		

Note:
1. Please note, we have done the heat load calculation based on provided architectural drawing, revision in architectural drawing may change the heat load calculation.
2. Please note that we have considered underdeck insulation in all exposed roof.
3. CPU Regenerative Room & Office Room shall be catered through split units and heat load shall be provided with Split AC Schedule.

PROJECT : 2x660 MW ENNORE STPP

SUBJECT : ESTIMATED HEAT LOAD CALCULATION SUMMARY SHEET FOR SERVICE BUILDINGS

S.No.	Name of Area	Design Conditions		Floor Area	Occupancy	Lighting Load	Equipment Load	Calculated							Selected					Type of Equipment	Selected Equipment (Capacity & Qty.)
		DB	RH					Summer Cooling	Monson Cooling	Monsoon Reheat	Winter Heating	Winter Humidification	Fresh Air	Deh. Air	Cooling Load	Heating Load	Humidifier Load	Fresh Air	Dehumidified Air		
		(Deg C)	(%)	(Sq.ft)	(Nos.)	(Watt)	(Watt)	(TR)	(TR)	KW	KW	KW	(CFM)	(CFM)	(TR)	(KW)	(KW)	(CFM)	(CFM)		
1	**Ground Floor**																				
1	**ZONE-1**																				
1.1	VIP Dining Room - 0.00m lvl	(24ºC±1)*	50±5	396.00	12	792	500	5.37	3.25	-4.00	-1.15	-0.06	240	1406	5.91	-4.40	-0.06	240.00	1546.00	Packaged AC	20 TR, 8000 CFM PAC 4 Nos (2W+2S)
1.2	VIP Lounge - 0.00m lvl			329.00	10	658	1000	3.09	2.52	-1.00	0.51	-0.05	200	765	3.40	-1.10	-0.05	200.00	841.00		
1.3	Telephone Exchange Room - 0.00m lvl			450.00	14	900	3000	5.31	4.25	-2.00	1.38	-0.07	280	1601	5.84	-2.20	-0.08	280.00	1761.00		
1.4	Library - 0.00m lvl			511.00	16	1022	500	3.74	3.51	0.00	0.22	-0.08	320	661	4.11	0.00	-0.09	320.00	727.00		
1.5	Simulator room - 0.00m lvl			511.00	16	1022	14500	8.67	8.44	0.00	8.87	-0.08	320	3546	9.53	0.00	-0.09	320.00	3901.00		
1.6	First Aid Room - 0.00m lvl			96.00	3	192	500	1.10	0.85	0.00	0.25	-0.01	60	287	1.20	0.00	-0.02	60.00	316.00		
1.7	Corridor - 0.00m lvl			1152.18	5	2304	0	6.13	3.36	-6.00	0.01	-0.06	255	1911	6.75	-6.60	-0.07	255.00	2102.00		
1.8	Examination Room - 0.00m lvl			69.00	2	138	300	0.96	0.60	-1.00	0.12	-0.01	40	284	1.06	-1.10	-0.01	40.00	312.00		
2	**ZONE-2**			**3514.18**	**78.00**	**7028.36**	**20300.00**	**34.36**	**26.78**	**-14.00**	**10.20**	**-0.42**	**1715.09**	**10460.75**	**37.80**	**-15.40**	**-0.47**	**1715.00**	**11506.00**		
1.9	Reception - 0.00m lvl	(24ºC±1)*	50±5	1820.00	8	3640	1000	7.97	5.27	-5.00	0.17	-0.10	403	2129	8.77	-5.50	-0.11	403.00	2342.00	Packaged AC	15 TR, 6000 CFM PAC 4 Nos (2W+2S)
1.10	Model Display room - 0.00m lvl			345.00	2	690	1000	1.62	1.28	-1.00	0.74	-0.02	76	544	1.78	-1.10	-0.02	76.00	599.00		
1.11	Safety and Welfare Cell - 0.00m lvl			196.00	4	392	500	1.12	1.06	0.00	0.37	-0.02	80	271	1.23	0.00	-0.02	80.00	298.00		
1.12	Environment Monitoring Room - 0.00m lvl			171.00	4	342	500	1.47	1.10	-1.00	0.29	-0.02	80	413	1.62	-1.10	-0.02	80.00	454.00		
1.13	Server Room - 0.00m lvl			143.00	4	286	2000	2.22	1.68	-1.00	1.08	-0.02	80	814	2.44	-1.10	-0.02	80.00	895.00		
1.14	UPS Room - 0.00m lvl			345.00	4	690	3000	3.05	2.26	-2.00	1.86	-0.02	80	1263	3.36	-2.20	-0.02	80.00	1390.00		
	Subtotal			**3020.00**	**26**	**6040**	**8000**	**17.45**	**12.64**	**-10.00**	**4.51**	**-0.20**	**799.33**	**5433.99**	**19.20**	**-11.00**	**-0.21**	**799**	**5978**		
2	**First Floor**																				
2.1	Conference Room - 4.25m lvl	(24ºC±1)*	50±5	624.00	24	1248	1250	7.98	5.78	-3.00	-0.45	-0.12	480	1625	8.77	-3.30	-0.13	480.00	1787.00	Packaged AC	15 TR, 6000 CFM PAC 4 Nos (2W+2S)
2.2	Record Room - 4.25m lvl			196.00	0	392	0	1.49	0.68	-2.00	-0.48	-0.01	39	589	1.64	-2.20	-0.01	39.00	648.00		
2.2	Executive/Engineer -Operation - 4.25m lvl			252.00	5	504	360	1.81	1.40	-1.00	0.03	-0.02	100	491	1.99	-1.10	-0.03	100.00	540.00		
2.3	Executive/Engineer- Training - 4.25m lvl			255.00	5	510	360	2.04	1.44	-1.00	0.00	-0.02	100	575	2.25	-1.10	-0.03	100.00	633.00		
2.4	Office Space for Non Executive - 4.25m lvl			4196	52	8392	7800	24	17	-17	6	0	1040	7791	13.25	-9.35	-0.14	520.00	4285.00		
															27.90	**-17.05**	**-0.34**	**1239.00**	**7893.00**	**Zone-1**	
															13.25	-9.35	-0.14	520.00	4285.00		
2.5	Electrical Lab - 4.25m lvl			345.00	4	690	2000	3.51	2.04	-3.00	1.12	-0.02	80	1287	3.87	-3.30	-0.02	80.00	1416.00	Packaged AC	15 TR, 6000 CFM PAC 4 Nos (2W+2S)
2.6	Executive/Engineer -EM1- 4.25m lvl			252.00	5	504	360	2.13	1.73	-1.00	0.03	-0.02	100	682	2.34	-1.10	-0.03	100.00	751.00		
2.7	Executive/Engineer -EM2- 4.25m lvl			255.00	5	510	360	2.14	1.73	-1.00	0.02	-0.02	100	702	2.36	-1.10	-0.03	100.00	772.00		
2.8	Switchyard Control Room- 4.25m lvl			453.00	2	906	2000	4.17	2.69	-3.00	0.47	-0.02	89	1668	4.59	-3.30	-0.02	89.00	1835.00		
2.9	Printer/Xerox Room- 4.25m lvl			311.00	2	622	1000	2.59	1.35	-2.00	0.18	-0.01	61	889	2.85	-2.20	-0.02	61.00	978.00		
	Total			**7139.00**	**104**	**14278**	**15490**	**51.96**	**35.50**	**-34.00**	**7.25**	**-0.53**	**2188.93**	**16299.34**	**29.26**	**-20.35**	**-0.26**	**950.00**	**10037.00**	**Zone-2**	
3	**Second Floor**																				
3.1	Meeting Room - 8.5m lvl	(24ºC±1)*	50±5	624.00	24	1248	1250	7.98	5.78	-3.00	-0.45	-0.12	480	1625	8.77	-3.30	-0.13	480.00	1787.00	Packaged AC	15 TR, 6000 CFM PAC 4 Nos (2W+2S)
3.2	Record Room - 8.5m lvl			196.00	0	392	0	1.49	0.68	-2.00	-0.48	-0.01	39	589	1.64	-2.20	-0.01	39.00	648.00		
3.3	Executive Engineer TGM - 8.5m lvl			252.00	5	504	360	1.81	1.40	-1.00	0.03	-0.02	100	491	1.99	-1.10	-0.03	100.00	540.00		
3.40	Office Space for Non Executive - 8.5m lvl			4709.00	52.00	9418.00	7800.00	24.54	17.35	-16.00	6.78	-0.25	1040.00	7899.06	13.50	-8.80	-0.14	520.00	4344.00		
															25.90	**-15.40**	**-0.31**	**1139.00**	**7319.00**	**Zone-1**	
															13.50	-8.80	-0.14	520.00	4344.00		
3.4	C&I Lab - 8.5m lvl			345.00	4	690	3000	3.87	2.39	-3.00	1.74	-0.02	80	1489	4.30	-3.30	-0.02	80.00	1638.00	Packaged AC	20 TR, 8000 CFM PAC 4 Nos (2W+2S)
3.5	Executive Engineer -C&I-1- 8.5m lvl			252.00	5	504	360	2.13	1.73	-1.00	0.03	-0.02	100	682	2.40	-1.10	-0.03	100.00	751.00		
3.6	Executive/Engineer -C&I-2- 8.5m lvl			255.00	5	510	360	2.13	1.73	-1.00	0.03	-0.02	100	685	2.40	-1.10	-0.03	100.00	753.00		
3.7	Executive Engineer Technical Services- 8.5m lvl			453.00	6	906	360	3.12	2.14	-2.00	-0.36	-0.03	120	1051	3.50	-2.20	-0.03	120.00	1156.00		
3.8	Executive Engineer AHS - 8.5m lvl			210.00	5	420	360	2.05	1.35	-2.00	-0.22	-0.02	100	589	2.30	-2.20	-0.03	100.00	648.00		
3.10	Executive Engineer CHS 8.5m lvl			308.00	5	616	360	2.66	1.49	-2.00	-0.15	-0.02	100	813	3.00	-2.20	-0.03	100.00	895.00		
	Total			**7604.00**	**111**	**15208**	**14210**	**51.76**	**36.02**	**-33.00**	**6.97**	**-0.55**	**2258.57**	**15913.46**	**31.40**	**-20.90**	**-0.31**	**1120.00**	**10185.00**	**Zone-2**	
4	**Third Floor**																				
4.2	Meeting Room - 12.5m lvl	(24ºC±1)*	50±5	624.00	24	1248	1250	7.98	5.78	-3.00	-0.45	-0.12	480	1625	8.77	-3.30	-0.13	480.00	1787.00	Packaged AC	15 TR, 6000 CFM PAC 4 Nos (2W+2S)
4.3	Record Room - 12.5m lvl			196.00	0	392	0	1.49	0.68	-2.00	-0.48	-0.01	39	589	1.64	-2.20	-0.01	39.00	648.00		
4.4	Executive Engineer/BM - 12.5m lvl			252.00	5	504	360	1.81	1.40	-1.00	0.03	-0.02	100	491	1.99	-1.10	-0.03	100.00	540.00		
4.10	Office Space for Non Executive - 12.5m lvl			4196.00	52.00	8392.00	7800.00	24.09	16.68	-17.00	6.32	-0.25	1040.00	7791.00	13.25	-9.35	-0.14	520.00	4285.00		
															25.65	**-15.95**	**-0.31**	**1139.00**	**7260.00**	**Zone-1**	
															13.20	-9.35	-0.14	520.00	4285.00		
4.4	Relay Testing Lab - 12.5m lvl			345.00	5	690	2000	3.71	2.22	-3.00	1.08	-0.02	100	1325	4.09	-3.30	-0.03	100.00	1457.00	Packaged AC	20 TR, 8000 CFM PAC 4 Nos (2W+2S)
4.5	Executive Engineer /Mill- 12.5m lvl			252.00	5	504	360	2.13	1.73	-1.00	0.03	-0.02	100	682	2.34	-1.10	-0.03	100.00	751.00		
4.6	Executive Engineer/ECHS- 12.5m lvl			255.00	5	510	360	2.13	1.73	-1.00	0.03	-0.02	100	685	2.35	-1.10	-0.03	100.00	753.00		
4.7	Labour Officer - 12.5m lvl			463.00	10	926	720	4.56	3.42	-3.00	-0.37	-0.05	200	1498	5.01	-3.30	-0.05	200.00	1648.00		
4.8	Labour Officer's Staff - 12.5m LVL			435.00	6	870	1000	2.89	1.96	-2.00	0.39	-0.03	120	941	3.17	-2.20	-0.03	120.00	1035.00		
4.9	Small Meeting Room - 12.5m lvl			311.00	14	622	1250	4.92	3.51	-3.00	-0.12	-0.07	280	1177	5.41	-3.30	-0.08	280.00	1294.00		
	Total			**7329.00**	**126**	**14658**	**15100**	**55.70**	**39.11**	**-36.00**	**6.46**	**-0.62**	**2558.57**	**16803.72**	**35.57**	**-23.65**	**-0.39**	**1420.00**	**11223.00**	**Zone-2**	

S.No.	Name of Area	Design Conditions		Floor Area	Occupancy	Lighting Load	Equipment Load	Calculated							Selected					Type of Equipment	Selected Equipment (Capacity & Qty.)
		DB	RH					Summer Cooling	Monson Cooling	Monsoon Reheat	Winter Heating	Winter Humidification	Fresh Air	Deh. Air	Cooling Load	Heating Load	Humidifier Load	Fresh Air	Dehumidified Air		
5	Fourth Floor	(Deg C)	(%)	(Sq.ft)	(Nos.)	(Watt)	(Watt)	(TR)	(TR)	KW	KW	KW	(CFM)	(CFM)	(TR)	(KW)	(KW)	(CFM)	(CFM)		
1	ZONE-1																				
5.1	Conference Room - 17.0m lvl	(24ºC±1)*	50±5	1386.00	50	2772	1250	14.47	12.07	-3.00	0.25	-0.24	1000	2496	15.92	-3.30	-0.27	1000.00	2745.00	Packaged AC	20 TR, 8000 CFM PAC 4 Nos (2W+2S)
5.2	Transmitter Lab - 17m lvl			345.00	3	690	2500	3.25	2.03	-3.00	1.48	-0.02	68	1263	3.58	-3.30	-0.02	68.00	1390.00		
5.3	Service Room - 17.0m lvl			135.00	2	270	500	0.77	0.69	0.00	0.46	-0.01	40	196	0.85	0.00	-0.01	40.00	215.00		
5.4	Pantry - 17.0m lvl			135.00	3	270	1000	1.28	1.07	0.00	0.70	-0.01	60	367	1.41	0.00	-0.02	60.00	403.00		
5.5	SE/MM2 - 17.0m lvl			192.00	3	384	360	2.16	1.39	-2.00	-0.22	-0.01	60	772	2.37	-2.20	-0.02	60.00	850.00		
5.6	SE/MM1 - 17.0m lvl			192.00	3	384	360	1.75	1.03	-1.00	-0.04	-0.01	60	533	1.93	-1.10	-0.02	60.00	586.00		
5.7	EA & Steno Room(MM1) - 17.0m lvl			133.00	2	266	360	0.89	0.67	0.00	0.34	-0.01	40	230	0.98	0.00	-0.01	40.00	254.00		
5.8	EA & Steno Room(MM2) - 17.0m lvl			133.00	2	266	360	1.08	0.85	0.00	0.23	-0.01	40	343	1.19	0.00	-0.01	40.00	378.00		
5.9	Office Corridor-17,0m lvl(Grid:-6-9/E-E')			399.00	2	798	350	2.31	1.48	-1.00	0.45	-0.02	79	655	2.54	-1.10	-0.02	79.00	721.00		
	Total			**2651.00**	**68.00**	**5302.00**	**6690.00**	**25.67**	**19.80**	**-9.00**	**3.22**	**-0.33**	**1367.90**	**6200.18**	**28.23**	**-9.90**	**-0.38**	**1368.00**	**6821.00**		
2	ZONE-2																				
5.10	Visitor Hall - 17.0m lvl	(24ºC±1)*	50±5	2386.00	12	4772	1500	10.50	7.34	-3.00	3.10	-0.11	470	2193	11.55	-3.30	-0.13	470.00	2413.00	Packaged AC	20 TR, 8000 CFM PAC 4 Nos (2W+2S)
5.11	CE Room - 17.0m lvl			515.00	10	1030	1500	4.11	3.15	-2.00	1.07	-0.05	200	1052	4.52	-2.20	-0.05	200.00	1157.00		
5.12	Rest Room - 17.0m lvl			245.00	6	490	1000	2.61	1.92	-1.00	0.48	-0.03	120	711	2.87	-1.10	-0.03	120.00	782.00		
5.13	EA & Steno Room - 17.0m lvl			135.00	2	270	200	0.66	0.59	0.00	0.27	-0.01	40	135	0.73	0.00	-0.01	40.00	149.00		
5.14	SE/C&P - 17.0m lvl			173.00	3	346	360	1.66	0.99	-1.00	-0.03	-0.01	60	493	1.82	-1.10	-0.02	60.00	542.00		
5.15	SE/Operation - 17.0m lvl			189.00	3	378	360	1.74	1.02	-1.00	-0.04	-0.01	60	538	1.92	-1.10	-0.02	60.00	592.00		
5.16	SE/Electrical - 17.0m lvl			189.00	3	378	360	1.94	1.13	-2.00	-0.25	-0.01	60	641	2.13	-2.20	-0.02	60.00	705.00		
5.17	EA & Steno Room(SE-Electrical) - 17.0m lvl			82.00	2	164	360	1.26	0.72	-1.00	0.09	-0.01	40	383	1.39	-1.10	-0.01	40.00	421.00		
5.18	EA & Steno Room(SE Operation) - 17.0m lvl			92.00	2	184	360	1.07	0.66	-1.00	0.24	-0.01	40	297	1.17	-1.10	-0.01	40.00	327.00		
5.19	EA & Steno Room(C&P) - 17.0m lvl			123.00	3	246	360	1.08	0.84	0.00	0.28	-0.01	60	248	1.19	0.00	-0.02	60.00	272.00		
5.20	Offices' Corridor - 17.0m lvl (Grid:-2-3/E-E')			252.00	1	504	250	1.12	0.80	0.00	0.37	-0.01	50	233	1.23	0.00	-0.01	50.00	257.00		
5.21	SE/CHP - 17.0m lvl			170.00	3	340	250	1.65	0.99	-1.00	-0.03	-0.01	60	490	1.81	-1.10	-0.02	60.00	539.00		
5.22	EA & Steno Room(CHP) - 17.0m lvl			119.00	3	238	360	1.07	0.84	0.00	0.27	-0.01	60	245	1.18	0.00	-0.02	60.00	270.00		
	Total			**4670.00**	**53.17**	**9340.00**	**7220.00**	**30.48**	**20.99**	**-13.00**	**5.82**	**-0.32**	**1319.16**	**7658.52**	**33.51**	**-14.30**	**-0.37**	**1320.00**	**8426.00**		
Note:	1. Please note, we have done the heat load calculation based on provided architectural drawing, revision in architectural drawing may change the heat load calculation.																				
	2.Please note that we have considered underdeck insulation in all exposed roof.																				
	3.Please note that we have not considered system for winter season.																				
*	Heat Load Calculation and System Sizing is done at 22ºC±1 and 50±5 RH. It is not possible to achive the required ADP by packaged AC at this conditon. Hence, Inside Room condition demonstrated at site shall be 24ºC±1 and 50±5.																				

PROJECT :2x660 MW STPP, ENNORE

SUBJECT : ESTIMATED HEAT LOAD CALCULATION SUMMARY SHEET FOR ADMIN BUILDINGS

S.No.	Name of Area	Floor Area	Occupancy	Lighting Load	Equipment Load	Cooling Load (Calculated)		HEATING LOAD		HUMIDIFIER CAPACITY	Air Quantity (Calculated)		Selected Capacity (Cooling Load) WITH 10% SAFETY		Selected Pan Humidifer (Capacity)	Selected Strip Heater (Capacity)	Type of Equipment	Selected Equipment (Capacity & Qty.)
						Summer Cooling	Monson Cooling	WINTER	REHEAT		Fresh Air	Deh. Air						
		(Sq.ft)	(Nos.)	(Watt)	(Watt)	(TR)	(TR)	KW	KW	KW	(CFM)	(CFM)	(TR)	CFM	(KW)	(KW)		
	GROUND FLOOR (EL 00.00 m LVL)																	
1	FINANCIAL CONTROLER	164.00	4	328	360	2.62	1.40	-0.96	-2.00	-0.02	80	633	2.88	697				
2	FINANCIAL CONTROLLER STAFF	248.00	6	496	900	1.72	1.61	0.55	0.00	-0.03	120	413	1.89	454				
3	FIRST AID ROOM	131.00	3	262	300	1.11	0.86	0.04	-1.00	-0.01	60	319	1.22	351				
4	OFFICE SPACE FOR P & A	1105.00	20	2210	2850	6.63	5.63	2.09	-2.00	-0.09	400	1761	7.29	1938				
5	EA P & A	47.00	3	94	360	0.91	0.74	0.12	0.00	-0.01	60	211	1.00	232	NA	11	WCPAC	15 TR PAC 4 NOS.(2W +2 S)
6	EA CIVIL	47.00	3	94	360	0.91	0.74	0.12	0.00	-0.01	60	211	1.00	232				
7	SE CIVIL	135.00	4	270	360	2.39	1.57	-0.12	-2.00	-0.02	80	815	2.63	896				
8	SE P & A	181.00	4	362	360	2.16	1.54	-0.13	-2.00	-0.02	80	770	2.38	847				
9	TELECOMMUNICATION	413.00	4	826	5000	3.44	3.04	3.09	-1.00	-0.02	91	1488	3.79	1636				
	SUB TOTAL-01	**2471.00**	**51**	**4942**	**10850**	**22.00**	**17.00**	**4.81**	**-10.00**	**-0.23**	**1031**	**6621**	**24.08**	**7283**				
1	MINI CONFERENCE ROOM	413.00	22	826	1250	6.04	5.11	-0.16	-2.00	-0.10	440	1276	6.64	1404				
2	PRINTER ROOM	94.00	1	188	500	0.45	0.43	0.38	0.00	0.00	21	159	0.49	175				
3	RECORD ROOM	125.00	1	250	250	0.71	0.46	0.19	0.00	-0.01	28	195	0.78	214				
4	SAFETY AND WELFARE CELL	383.00	8	766	750	3.12	2.29	0.13	-1.00	-0.04	160	552	3.43	607				
5	PANTRY BESIDE LIBRARY	115.00	2	230	500	0.66	0.63	0.36	0.00	-0.01	40	188	0.72	206				
6	LIBRARY	437.00	5	874	1500	1.94	1.78	1.22	0.00	-0.02	100	621	2.14	684				
7	PANTRY BESIDE ATM	64.00	1	128	400	0.55	0.40	0.26	0.00	0.00	20	191	0.60	210	NA	15.4	WCPAC	20 TR PAC 4 NOS.(2W +2 S)
8	ATM	54.00	1	108	500	0.73	0.47	0.26	-1.00	0.00	20	268	0.80	294				
9	LOBBY	288.00	2	576	300	1.13	0.91	0.27	0.00	-0.01	64	305	1.24	335				
10	POST OFFICE	605.00	6	1210	750	5.64	3.33	-1.24	-4.00	-0.03	134	1929	6.20	2121				
11	BANK EXTENSION COUNTER	785.00	8	1570	900	5.15	3.49	-0.51	-3.00	-0.04	174	1734	5.67	1907				
12	ENTRANCE LOBBY	2119.72	10	4239	300	8.11	6.62	0.26	-3.00	-0.10	469	2372	8.92	2610				
	SUB TOTAL-01	**5483.00**	**67**	**10965**	**7900**	**34.00**	**26.00**	**1.00**	**-14.00**	**-0.37**	**1669**	**9789**	**37.63**	**10767**				
	FIRST FLOOR (EL 4.5 m LVL)																	
1	CONFERENCE ROOM - FF	1065.00	50	2130	1250	15.71	12.03	-1.45	-5.00	-0.22	1000	2930	17.28	3223	NA	13	WCPAC	20 TR PAC 4 NOS.(2W +2 S)
2	OFFICE ADMIN AND ACCOUNTS - 1 (FF)	1693.00	40	3386	4000	15.76	12.26	2.67	-7.00	-0.18	800	4199	17.34	4618				
	SUB TOTAL-01	**2758**	**90**	**5516**	**5250**	**31.00**	**24.00**	**1.00**	**-12.00**	**-0.40**	**1800**	**7129**	**34.62**	**7841**				
1	EXE ENGG MECH - FF	113.00	3	226	360	1.75	1.24	0.07	-1.00	-0.01	60	583	1.93	641				
2	EXE ENGG ELEC - FF	117.00	3	234	360	1.59	1.10	0.09	-1.00	-0.01	60	487	1.75	535				
3	EXE ENGG CIVIL - FF	113.00	3	226	360	1.24	1.04	0.19	0.00	-0.01	60	362	1.37	398				
4	PRINTER ROOM - FF	134.00	1	268	500	1.10	0.63	0.41	-1.00	-0.01	26	352	1.21	387	NA	21	WCPAC	20 TR PAC 4 NOS.(2W +2 S)
5	STORE ROOM - FF	139.88	1	280	0	0.74	0.43	0.13	0.00	-0.01	28	179	0.81	196				
6	OFFICE ADMIN AND ACCOUNTS - 2 - FF	1734.00	45	3468	4500	18.02	13.01	1.47	-8.00	-0.20	900	4370	19.83	4807				
7	OFFICE ADMIN AND ACCOUNTS - 3 - FF	999.00	16	1998	1600	6.35	4.85	1.72	-2.00	-0.07	320	1504	6.98	1654				
8	OFFICE FOR AEE,AE & STAFF	882.32	16	1765	1600	8.98	6.04	0.16	-6.00	-0.07	320	2824	9.88	3106				
	SUB TOTAL-01	**4232**	**88**	**8464**	**9280**	**40.00**	**28.00**	**4.00**	**-19.00**	**-0.39**	**1774**	**10659**	**43.76**	**11724**				
Note:	1. Please note, we have done the heat load calculation based on provided architectural drawing, revision in architectural drawing may change the heat load calculation.																	
	2.Please note that we have considered underdeck insulation in all exposed roof.																	

PROJECT : 2x660 MW TPP ENNORE TPS

SUBJECT : ESTIMATED HEAT LOAD CALCULATION SUMMARY SHEET FOR ESP BUILDINGS

S.No.	Name of Area	Floor Area	Occupancy	Lighting Load	Equipment Load	Cooling Load (Calculated)		HEATING LOAD		HUMIDIFIER CAPACITY	Air Quantity (Calculated)		Selected Capacity (Cooling Load) WITH 10% SAFETY		Selected Equipment					
						Summer Cooling	Monson Cooling	WINTER	REHEAT		Fresh Air	Deh. Air			Selected Pan Humidifer (Capacity)	Selected Strip Heater (Capacity)	Type of Equipment	Capacity		Qty.
		(Sq.ft)	(Nos.)	(Watt)	(Watt)	(TR)	(TR)	KW	KW	KW	(CFM)	(CFM)	(TR)	CFM	(KW)	(KW)		TR.	CFM	NOS
	ESP BUILDING-UNIT -01																			
1	SWITCH GEAR ROOM-ESP UN-01	1892.00	9	3784	18000	21.93	13.57	9.88	-16.00	-0.10	465	9067	24	9974	1.5	17.6	F.M. A.H.U (DX TYPE)	30	10000	2(1 W+1S)
	ESP BUILDING-UNIT -02																			
2	SWITCH GEAR ROOM-ESP UN-02	1892.00	9	3784	18000	21.93	13.57	9.88	-16.00	-0.10	465	9067	24	9974	1.5	17.6	F.M. A.H.U (DX TYPE)	30	10000	2(1 W+1S)
	F.M. A.H.U -	FLOOR MOUNTED AIR HANDLING UNIT																		
	W+S -	WORKING +STAND BY																		

Note:

1. Please note, we have done the heat load calculation based on provided architectural drawing, revision in architectural drawing may change the heat load calculation.
2. Please note that we have considered underdeck insulation in all exposed roof.

APPROVED VIDE TANGEDCO LETTER NO. CE/P/SE/M/P/EE-10/E/P/F.2x660 MW Ennore SEZ STPP/ D.60 /14, DATED 27.09.2019

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Revised as per TANGEDCO / DESEIN Comments. Reviewed by BHEL and found in order. Submitted for customer approval.
2019.07.30 15:58:23 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
30/07/2019	01	REVISED AS PER DESEIN OBSERVATION ON THE DOCUMENT DATED 26/06/2019. DOCUMENT IS REVISED INCORPORATING COMMENTS AND REPLACED AS PER DISCUSSION IN ERM DATED 30/07/2019. CHANGES ARE DONE IN GREED COLOR FOR IDENTIFICATION.	NAYAB	NAYAB	SKT
18/07/2019	01	REVISED AS PER TANGEDCO / DESEIN COMMENTS DTD 10/07/2019 – CHANGES ARE DONE IN BLUE COLOR FOR IDENTIFICATION. SUPERSEEDED	NAYAB	NAYAB	SKT
19/06/2019	00	FIRST SUBMISSION	NAYAB	NAYAB	SKT

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301
JOB No. **412**	
STATUS **CONTRACT**	**DOC. NO: PE-V0-412-553-A012** Rev: **01**
PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**OPERATION & CONTROL PHILOSOPHY FOR AC SYSTEM**

1.0 THE AIR CONDITIONING SYSTEM COVERS FOLLOWING AREAS.

A) Air-Conditioning System at TG Building-Control Room Control Equipment Room, UPS Room & SWAS Room.
B) Air-Conditioning System at ESPs Building, Unit#01
C) Air-Conditioning System at ESPs Building, Unit#02
D) Air-conditioning System for Service Building.
E) Air-conditioning System for Admin Building.

2 .0 DETAILED OPERATION & CONTROL OF AC SYSTEM TG BUILDING, ESP BUILDING, SERVICE BUILDING & ADMIN BUILDING

AC System of TG Building, ESP building, Service Building and Admin Building shall be controlled by **DDCMIS.**

2.1 OPERATION & CONTROL OF AC SYSTEM

DDCMIS (BHEL's scope) system shall consist of following Graphics pages in which P&I diagram are to be prepared with all necessary Pop-up Windows Display parameters & Alarm Configuration.

a) Graphics for AC Plant Room of TG building.
b) Graphics for AHU (1-3) at (+) 24.0M of TG Building.
c) Graphics for AHU (4-5) at (+) 8.5M of TG Building.
d) Graphics for FCU (1-6) at (+) 0.0M of SWAS Room TG Building.
e) Graphics for AC System of ESP Building for Unit 1
f) Graphics for AC System of ESP Building for Unit 2
g) Graphics for AC System of Service Building.
h) Graphics for Package AC Room all Rooms (Ground to 4th Floor) of Service building.
i) Graphics for AC System of Admin Building.
j) Graphics for Package AC Room all Rooms (Ground and 1st Floor) of Admin building.

Each Graphics shall have POP up windows by which plant is operated.

Each Graphics shall have **Auto & Manual** Selection by which operator is to decide in which mode system will run. Before that Operator is to do selection of Standby and Working drive from respective Graphics page.

When **Manual mode** is selected in respective Graphics then individual equipment of that particular area can be operated by actuation of start & stop PB (soft button available in POP of respective drive) from Graphics.

When **Auto mode** operation is selected for any particular Graphics then total system of that particular area operates automatically in sequence as per the preset program in DDCMIS provided that **"Auto start"** Command is given. Similarly Auto operation will be stopped in sequence if **"Auto Stop"** Command is given from Graphics.

All drives will have individually **Service / Maintenance** mode selection in respective POP-UP WINDOWS but by default they will be in Service mode only. In duty cycle sequence preset running time can be changed through Graphics and run time duration completed will be continuously displayed in Graphics until reset by operator. When preset run time is completed then there will alarm with message in Graphics. Accordingly, operator will take decision for further selection.

A) OPERATION & CONTROL OF AIRCONDITIONING SYSTEM OF TG BUILDING

3.0 EQUIPMENT DETAILS OF AIR CONDITIONING SYSTEM OF TG BUILDING

The AC system in TG Building area consists of the following major equipment's:

3.1 2 nos. Screw Chilling machines (1W+1S) are located at AC plant room of TG Building.

3.2 2 nos. Chilled water pumps (1W+1S) are located at AC plant room of TG Building.

3.3 2 nos. Condenser water pumps (1W+1S) are located at AC plant room of TG Building.

3.4 4 nos. AHU's(2W+2S) (AHU 1-4) located at 24.0M of TG Building along with accessories like 3-way Mixing Valves, Fresh Air fan, Heaters, VFD for AHU FAN, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. to provide Air Conditioning to Common Control Room & Control Equipment Room at EL 17.0M of TG Building Control Equipment Room.

3.5 2 nos. AHU's(1W+1S) (AHU 5-6) located at 8.5M of TG Building along with accessories like 3-way Mixing Valves, Fresh Air fan, Heaters, VFD for AHU FAN, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. to provide air conditioned to UPS room of TG Building.

3.6 6nos - (6W) FCU'S (1-6) for SWAS Room of TG Building Unit 1 & 3 along with accessories like 2-way mixing valves, temperature & RH Sensors, Fire Dampers etc.

3.7 2nos. Cooling towers (1W+1S) are located at terrace of TG building.

4.0 DETAILED OPERATION OF DRIVES IN NORMAL MODE FOR MAIN PLANT BUILDING

The basic function of the system is to closely control and monitor inside temperature and humidity conditions inside the air-conditioned spaces, to optimize/minimize energy consumption by automated operation, to provide remote centralized monitoring & control for various mechanical facilities including sequential start/stop of the whole HVAC System, automatically calculate record and cooling load for each hour / day / season, to generate maintenance data & alarms, to maintain records of plant operation & energy consumption for varying loads, duty cycling to operate all the equipment including standby equipment for equal duration, automatic startup of standby equipment in case of failure of operating unit and displaying fault alarm status of the tripped unit, activating / deactivating water valves to startup/stop water flow through chiller/condenser circuit. For sequential operation /duty cycling, Programmed startup/stop of individual AHU as per operating requirements and for maintaining the room temperature / RH by controlling the 3 way mixing valves at chilled water line, humidified system and duct heater.

Bearing above in mind, control philosophy for Air Conditioning System is prepared.

4.1 When "Manual" mode is selected in respective Graphics then system can be operated in the following steps.

STEP-1
(AHU Operation at any Particular Area – 24.0 M & 8.5 M)

Open the Graphics of AHUs at any particular level and select the operation in "**manual mode"**.

Select the AHU Fan to start from respective POP up window in Graphics. Required no's AHU Fans are to be selected for working mode from OWS. Rest nos. are to be kept in Standby mode for auto Change over during auto operation of AC system.

Now **"Start"** command for any selected AHU can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

a) It is selected in Service mode.
b) It is selected in Working mode.
c) Variable Frequency Drive is healthy
d) Off Signal Feedback is available from VFD
e) No fire signal.
f) Fire damper open feedback
g) At least minimum one no or required nos. Fire Damper are open. This will be ensured by each damper Limit switch. Normally all Fire Dampers will remain open until main power supply is switched off or there is no fire signal in DDCMIS from Firefighting panel. All Dampers will be closed if fire signal is received in DDCMIS from Fire Fighting system. Closure of fire damper shall raise annunciation in the panel.

VFD Fan Operation:

AHU Fan shall be operated through VFD. VFD shall regulate AHU fan based on Differential Pressure signal obtained from the DPT mounted inside the Control Room / Air Conditioned Area (Signal from DPT shall be transferred to DDCMIS and later to VFD through DDCMIS). VFD shall be operated to maintain a positive pressure of min. 5.0 MMWC (adjustable) inside the Control Room / Air Conditioned Room. AHU Fan speed will be increased if the pressure inside the Control Room Falls below 5.0MMWC (adjustable) and decrease if the pressure inside the control room goes beyond 8.0 MMWC (adjustable) for which VFD shall be programmed.

If above interlocks are through then selected AHU Fan will be running provided that start command is issued from Graphics.

Following **protection features** have been considered to trip the running AHU Fan and FCU.

a) Start command from DDCMIS to VFD will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) AHU Fan will be tripped also if fan outlet Pressure is not developed within 15 second after running of Fan. Similarly, during running of Fan, if fan Pressure becomes low, that time also fan will be immediately tripped.
c) AHU Fan will be tripped immediately if fire signal exists.
d) AHU Fan will be tripped immediately if close feedback of any / all fire dampers of respective area are available.

Following are the **Status indication** details in OWS for AHU Fan and its accessories instrumentation.

a) Respective AHU fan running status will be displayed in Graphics as red color
b) Respective AHU fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.
d) **Filter chocked** (Switching signal from DP switch provided across the Plenum) of each AHU) Alarm message will be displayed in graphics. Switch signal occurs when differential pressure across the filter comes above Set Point (75 Pascal for Pre, 175 Pascal for Fine Filter and 500 Pascal for Hepa

Filter (Adjustable)).

e) **"AHU fan pressure is insufficient"** will be displayed as alarm message in Graphics. This switching signal (through DP switch shall be provided at each AHU Fan outlet) occurs when AHU Fan Outlet Pressure is not achieved above 250 Pascal(Adjustable) during starting condition as well as in running condition.

f) Open & close status of Fire Damper shall be displayed in Graphics as red & Green Color respectively.

When the AHU start, following conditions will be also monitored & controlled through DDCMIS

a) If any filter system in any of the AHU is choked there will be alarm at Graphics.

b) 3-way motorized mixing valve (provided at each AHU return chilled water piping) operation will be functioning while respective AHU fan is under running condition. Its modulation function (open/ close) will be based on the value of RA temperature (measured at return AHU path) with respect to set point from Graphics set point (23 Deg C, resettable from DDCMIS). Set point can be seen or can be changed from Graphics. Depending upon this set point & current return air temperature DDCMIS will modulate the opening of 3-way mixing valve. Mixing valve will be opened more if, return air temperature (say 25 Deg C) is greater than the set point (here 23 Deg C) & it will be closed if, return air temperature (say 20 Deg C) is lesser than the set point (here 23 Deg C).

#FCU OPERATION AT ANY PARTICULAR AREA

Select the FCU to start from respective POP in Graphics. Required 3 no's. FCU (Per Unit) are to be selected for **working mode** from OWS.

Now **"Start"** command for any selected FCU can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

a) It is selected in Service mode.
b) It is selected in **working mode.**
c) MCC Disturbed Signal from MCC.
d) Off Signal Feedback is available from MCC
e) No fire signal.
f) Fire damper open feedback

At least minimum one no or required nos. Fire Damper is open. This will be ensured by each damper Limit switch. Normally all Fire Dampers will remain open until main power supply is switched off or there is no fire signal in DDCMIS from Firefighting panel. All Dampers will be closed if fire signal is received in DDCMIS from Fire Fighting system.

If above interlocks are through then selected FCU will be running provided that start command is issued from Graphics.

Following **protection features** have been considered to trip the running FCU.

a) MCC Disturbed Signal from MCC.
b) FCU will be tripped immediately if fire signal exist.
c) FCU will be tripped immediately if close feedback of all fire dampers are available.

Following are the **Status indication** details in OWS for FCU and its accessories instrumentation.

a) Respective FCU running status will be displayed in Graphics as red color
b) Respective FCU off status will be displayed in Graphics as Green color.
c) Open & close status of Fire Damper shall be displayed in Graphics as red & Green Color respectively.

STEP-2
(Fresh air fan Operation)

2No Fresh air fan (2W+0S) is provided inside each AHU Room of TG Building. It will be started after running of any AHU. Its Permissive signal for operation is as below.

a) It is selected in Service mode.
b) It is selected in **Remote Mode.**
c) MCC Disturbed Signal from MCC.
d) Off Signal Feedback is available from MCC
e) No fire signal.
f) At least any one AHU is in running condition.

Now if all above permissive signals are available then FAF drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running AHU Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) FA Fan will be tripped as soon as received of MCC Disturbed Signal from MCC.
c) FA fan will be tripped if DDCMIS receives Fire signal from Fire Fighting Panel.

Following are the **Status indication** details of FA Fan in OWS.

a) Respective FA fan running status will be displayed in Graphics as red color.
b) Respective FA fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.

STEP-3
(Cooling Tower Operation)

Select the Cooling Tower to start from respective POP in Graphics. Required 1 no. CT Fan is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system.

As soon as anyone CT Fan is selected for working, its Inlet line **motorized valve** will be also opened automatically.

Now **“Start”** command for any selected CT Fan can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in Service mode.
b) It is selected in Remote Mode.

c) CT Inlet valves open feedback available.
d) MCC Disturbed Signal from MCC.
e) At least any one AHU is in running condition.

Now if all above permissive signals are available then CT Fan drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CT Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
g) CT fan will be tripped as soon as received of MCC Disturbed Signal from MCC.
b) CT Fan will be tripped if tank water level becomes low for particular time (30 Seconds)
c) CT Fan will be stopped upon receiving of inlet valve close signal

Following are the **Status indication** details of CT Fan in OWS.

a) Respective CT fan running status will be displayed in Graphics as red color.
b) Respective CT fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics as amber color with alarm message.

STEP-4
(Selection of Chiller Machine (Screw Chiller))

Required 1no Chiller Machine is selected for **working mode** from OWS. Rest one no is to be kept in **Standby mode** for auto Change over during auto operation of AC system (Auto change over shall not be happened if standby Chiller Machines are kept in **maintenance mode**).

As soon as any Chiller Machine is selected for working, its **Condenser & Chilled water outlet line motorized valves** will be opened automatically.

Similarly, Condenser & Chilled Water outlet line motorized valve of standby machine shall be closed / remain closed.

STEP-5
(Condenser Water Pump Operation)

Select the Condenser Water Pump (CWP) to start from respective POP in Graphics. Required 1no CWP is to be selected for **working mode** from OWS. Rest 1no is to be kept in **Standby mode** for auto Change over during auto operation of AC system. (Auto change over shall not be happened if standby Condenser Water Pump are kept in **maintenance mode**).

As soon as anyone CWP is selected for working, its outlet line **motorized valve** will be also opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

Now **“Start”** command for any selected CWP can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode.**

c) **CWP outlet Valve** open feedback available**.**
d) **Chiller's** Condenser Water Outlet Valve open feedback.
e) MCC Disturbed Signal from MCC.
f) **At** least any one CT fan running condition.

Now if all above permissive signals are available then CWP drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CWP.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) CWP will be tripped as soon as received of MCC Disturbed Signal from MCC.
c) CWP will be tripped immediately if Cooling Tower tank low level is available.
d) CWP will be tripped if pump outlet pressure is not developed within particular time (30 seconds) after running of Pump. Pump outlet pressure will be displayed in Graphics.
e) CWP will be stopped upon receiving of pump outlet valve close signal.
f) CWP will be stopped upon receiving of CHILLER condenser water inlet valve close signal

Following are the **Status indication** details of CWP in OWS.

a) Respective CWP running status will be displayed in Graphics as red color with rotating movement.
b) Respective CWP off status will be displayed in Graphics as Green color with rotating movement.
c) Respective CWP Trip status will be displayed in Graphics as Amber Color with Alarm message.

STEP 6
(Chilled water pump operation)

Required 1nos Chilled Water Pumps **(CHWP)** is to be selected for **working mode** from OWS. Rest 1 no are to be kept in **Standby mode** for auto Change over during auto operation of AC system. (Auto change over shall not be happened if standby Chilled Water Pump are kept in **maintenance mode**).

As soon as anyone Chilled Water Pump is selected for working, its outlet line **motorized valve** will be also opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

Now following **permissive interlocks** are required to start selected Chilled Water Pump from Graphics.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode.**
c) **CHWP outlet Valve** open feedback available**.**
d) **Chiller's** Chilled Water Outlet Valve open feedback.
e) **MCC Disturbed Signal from MCC.**
f) Any AHU run feedback.

Now if all above permissive signals are available then selected Chilled Water Pump can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running Chilled Water Pump.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) CHWP will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) Chilled water Pump will be tripped if Expansion tank level becomes low becomes low for particular time (30 Seconds)
d) CHWP will be tripped if pump outlet pressure is not developed within particular time (30 seconds) after running of Pump. Pump outlet pressure will be displayed in Graphics. If CHWP Pressure becomes low, that time also CHWP will be immediately tripped. Pump Header pressure will be displayed in Graphics.
e) CHWP will be stopped upon receiving of pump outlet valve close signal.
f) CHWP will be stopped upon receiving of CHILLER chilled water inlet valve close signal

Following are the **Status indication** details for Chilled Water Pump and its accessories instrumentation.

a) CHWP running status will be displayed in Graphics as red color with rotating movement.
b) CHWP off status will be displayed in Graphics as Green color
c) CHWP Trip status will be displayed in Graphics as Amber Color with Alarm message.
d) Expansion tank water level healthy status will be displayed in Graphics.

STEP -7
(Screw Chiller operation)

It has been already stated in Step-4 that Chiller machine working selection are to be done after running of AHUs for opening its Chilled and Condenser water outlet valve, without opening those valves any Chilled and Condenser Water Pump cannot be started and to start Chiller machine following permissive are need to be satisfied.

Permissive signal for selected Chiller Machine will be as below.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode**
c) **Motorized valves** open signal at Chilled water outlet line of selected Chiller machine are available.
d) **Motorized valves** close signal at Chilled water outlet line of standby Chiller machine are available.
e) **Motorized valves** open signal at Condenser water outlet line of selected Chiller machine are available.
f) **Motorized valves** close signal at Condenser water outlet line of standby Chiller machine are available.
g) Any 1 no. Chilled Water Pumps is running.
h) Any 1 no. Condenser Water Pumps is running.
i) Any 1 no. Cooling Tower is running.
j) Any one AHU is in running condition
k) Condenser Water Flow through Chiller Machine is healthy (Signal from Flow switch)
l) Chilled Water Flow through Chiller Machine is healthy (Signal from Flow switch)

If above permissive signals are available, then selected chiller machine can be started from OWS as well as Chiller Machine panel. **After giving start command by above, the Internal System of machine will be checked by its own dedicated control panel. If found ok, then selected Chiller**

machine will start. Start indication & alarm will be shown at OWS & the stand by Chiller Machine is to be selected for operation & the same can be started as per above procedure.

Following **protection features** have been considered to trip the running Chiller Machine.

a) Chiller Machine shall trip if any of the start permissive signal listed above is not satisfied.

Redundant soft interfacing and Hardwired interfacing shall be included for signal exchange between Air conditioning PLC and chiller's Microprocessor based control panel.

STEP -8
#DUCT HEATER & PAN HUMIDIFIER OPERATION

Duct heater or Pan Humidifier (both are provided inside AHU room) will be controlled & monitored automatically by the logic depending on the value of return **Air Temperature & RH on Graphics**. **ON & OFF status** of respective heater & Pan Humidifier can be seen in Graphics. Pan Humidifier will be functioning at lower limit of RH while heaters will be functioning at upper limit of RH. Heater will be also functioning at lower value of temperature.

DUCT HEATER PERMISSIVE:
Duct heater has 3 steps - Duct heater **step-1** switches **ON** if return air temperature falls below **20ºC** and switches **OFF** if temperature rises above **22ºC**. Similarly, Duct heater step 2 & 3 switches ON if return air temperature falls below 18 ºC & 16ºC respectively and switches OFF if temperature rises above 20 ºC & 18ºC respectively. Safety thermostat, called Airstat, is provided on duct at heater outlet to trip heaters of all steps in case supply air temperature is abnormally high.

Heater will also maintain the RH in monsoon. If the RH value exceeds 55% (adjustable), then the heater step-1 will start to maintain the RH at 50% (cut-off point). However, the heater will be stopped, if the temperature increases above 24 Deg. C.

Other Start permissive for Duct Heater:
a) Heater Air Stat (Thermostat) is healthy (integral part of heater)
b) Duct air pressure is healthy

PAN HUMIDIFIER PERMISSIVE:

a) Return Air RH in AHU room is less than Reference set point (45%-adjustable) with Cut-off at 50% (adjustable)
b) Humidifier Gyserstat is healthy (Safety Thermostat Temperature is not high) (integral part of humidifier) -
c) Humidifier water level healthy (Water level in pan Humidifier is not low) (integral part of humidifier)

STEP -9
#FIRE DAMPER OPERATION

FIRE/SMOKE sensed by the FDA sensor installed in the Air Conditioning Area will send feedback to the FPS Control Panel which in turn send signal to DDCMIS for Air Conditioning System. Suitable no. of potential free contact shall be provided in the fire alarm panel by Fire Protection Supplier. On Receipt of fire signal, command from DDCMIS shall be generated for the closure of fire dampers to cut off the air supply to the affected area.

Simultaneously, run permissive for AHU, Fresh Air Fan shall be withdrawn and annunciation will be generated in the DDCMIS (AC Control System) panel.

In this process now the total system will be in operation & will continue to run if not stopped manually or by some fault.

5.0 DETAILS OPERATION OF DRIVES IN AUTO MODE AT TG BUILDING - AUTOMATIC START SEQUENCE

When **Auto mode** operation is selected in respective Graphics, the total system will wait further to receive **"Auto Start"** command and if it is done then system will run automatically in sequence as per the preset program in DDCMIS.

Before giving "**Auto Start"** command from Graphics, operator is to **Select** desired drives in working mode which need to be started from Graphics.

Now "**Auto Start"** command can be given from Graphic and DDCMIS will immediately scan/check all interlocks (as explained in manual mode) and if found satisfactory will start all drives in the following sequentially.

AUTO START SEQUENCE STEP-1

AHU/FCU systems (Pre-selected or selected serially by default) in different areas will start automatically in sequence one by one (up to maximum working nos.) with preset time lag programmed in DDCMIS. If any AHU/FCU fail to start or develops trouble during running, the standby AHU/FCU (if it is selected in Service and Standby mode) of that area will start automatically.

AUTO START SEQUENCE STEP-2

Fresh air fan of the respective AHU Room will also start automatically. If at least one AHU Fan Run feedback is available of respective AHU room.

AUTO START SEQUENCE STEP-3

Cooling Tower Fan selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected CT Fan are healthy as explained in manual mode. Under running condition if any CT Fan is tripped then standby CT Fan (subject to CT Fan is selected in Service & Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-4

Condenser Water Pump selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected Condenser Water Pump are healthy as explained in manual mode. Under running condition if any Condenser Water Pump is tripped then standby pump (subject to Pump is selected in Service & Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-5

Chilled water Pump selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected Chilled Water Pumps are healthy as explained in manual mode.

Under running condition if any Chilled Water Pump is tripped then standby pump (subject to Pump is selected in Service & Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-6

- Based on the running feedback signal of the Chilled Water Pump, AHU and Open & Close feedback of motorized valves (Chilled water line of selected/non selected Chiller machine), Flow Healthiness, Pressure healthiness feedback (details are mentioned in manual mode) selected Chiller machine (Screw Chiller) will Start**.**

- Modulation (opening/Closing) of 3 Way Mixing valve will be functioned based on the value of RA temperature & Relative Humidity with respect to the set point.

- When the AHU starts the duct heater or Pan Humidifier will also be controlled (on/off) & monitored by the DDCMIS depending on the value of RA temperature /RH with respect to the set point.

Operation of entire AC system as per above stated process will remain in running condition if not ''Auto Stop'' command is given from Graphics.

5.1 AUTOMATIC STOP SEQUENCE

Now "Auto Stop" command can be given from Graphic and DDCMIS will immediately Stop all drives in the following sequentially.

a) All Chiller machine (Screw Chiller) will stop.
b) All Chilled water pump will stop.
c) All Condenser water pump will stop.
d) All Cooling Tower will stop.
e) Fresh Air Fan will stop.
f) All AHU will stop.

Hence Air-conditioning system will stop automatically.

To Stop the System manually, Stop command to Air Conditioning Equipment shall be given in the sequence described above.

B) OPERATION & CONTROL OF AIRCONDITIONING SYSTEM OF ESP BUILDING (UNIT 1 & UNIT 2)

6.0 EQUIPMENT DETAILS OF AIR CONDITIONING SYSTEM OF ESP BUILDING

The AC system in ESP Building area consists of the following major equipment's:

6.1 2 nos. Water Cooled condensing unit (1W+1S) are located at AC plant room EL (+) 8.7M of ESP Building.
6.2 2 nos. Condenser water pumps (1W+1S) are located at AC plant room EL (+) 8.7M ESP Building.
6.3 2 nos. Cooling Towers (1W+1S) are located at terrace of ESP Building.
6.4 2 nos. Dx-AHU's (1W+1S) located at 12.3M of ESP Building along with accessories like Fresh Air fan, Heaters, VFD for AHU Fan, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc.

7.0 DETAILED OPERATION OF DRIVES IN MANUAL MODE FOR ESP BUILDING

7.1 When "Manual" mode is selected in respective Graphics then system can be operated in the following steps.

STEP-1
(Operation of Water Cooled Condensing Unit (DX Type)

Select the DX-AHU Fan to start from respective POP up Window in Graphics of ESP Building and select the operation in "**manual mode"**. Required 1 no. AHU Fan is to be selected for **working mode** from OWS. Rest 1 no is to be kept in **Standby mode** for auto Change over during auto operation of AC system (Auto change over shall not be happened if standby AHU or Standby Water Cooled Condensing Unit is kept in **maintenance mode**).

Now **"Start"** command for any selected DX-AHU can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

DX-AHU Start permissive.

a) It is selected in Service mode.
b) AHU is in working mode.
c) VFD is Healthy signal available from VFD
d) Off Signal Feedback Available from VFD
e) Fire damper open feedback.
f) No fire signal.
g) At least minimum one no or required nos. Fire Damper are open. This will be ensured by each damper Limit switch. Normally all Fire Dampers will remain open until main power supply is switched off or there is no fire signal in DDCMIS from Firefighting panel. All Dampers will be closed if fire signal is received in DDCMIS from Fire Fighting system. Closure of fire damper shall raise annunciation in the panel.

VFD Fan Operation:

AHU Fan shall be operated through VFD. VFD shall regulate AHU fan based on Differential Pressure signal obtained from the DPT mounted inside the Control Room / Air Conditioned Area (Signal from DPT shall be transferred to DDCMIS and later to VFD through DDCMIS). VFD shall be operated to maintain a positive pressure of min. 5.0 MMWC (adjustable) inside the Control Room / Air Conditioned Room. AHU Fan speed will be increased if the pressure inside the Control Room Falls

below 5.0MMWC (adjustable) and decrease if the pressure inside the control room goes beyond 8.0 MMWC (adjustable) for which VFD shall be programmed.

If above interlocks are healthy then selected Dx-AHU Fan will be running provided that start command is issued from Graphics.

Following **protection features** have been considered to trip the running DX-AHU Fan.

a) Start command from DDCMIS to VFD will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) AHU Fan will be tripped also if fan outlet Pressure is not developed within 15 second after running of Fan. Similarly, during running of Fan, if fan Pressure becomes low, that time also fan will be immediately tripped.
c) AHU Fan will be tripped immediately if fire signal exists.
d) AHU Fan will be tripped immediately if close feedback of any / all fire dampers of respective area are available.

Following are the **Status indication** details in OWS for DX-AHU Fan and its accessories instrumentation.

a) Respective AHU fan running status will be displayed in Graphics as red color
b) Respective AHU fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.
d) **Filter chocked** (Switching signal from DP switch provided across the Plenum) of each AHU) Alarm message will be displayed in graphics. Switch signal occurs when differential pressure across the filter comes above Set Point (75 Pascal for Pre, 175 Pascal for Fine Filter and 500 Pascal for Hepa Filter (Adjustable)).
e) **“AHU fan pressure is insufficient”** will be displayed as alarm message in Graphics. This switching signal (through DP switch shall be provided at each AHU Fan outlet) occurs when AHU Fan Outlet Pressure is not achieved above 250 Pascal(Adjustable) during starting condition as well as in running condition.
f) Open & close status of Fire Damper shall be displayed in Graphics as red & Green Color respectively.

When the AHU start, following conditions will be also monitored & controlled through DDCMIS

a) If any filter system in any of the AHU is choked there will be alarm at Graphics.

STEP-2
(Fresh air fan Operation)

2 No Fresh air fan (2W+0S) is provided inside each AHU Room of ESP Building. It will be started after running of any AHU. Its Permissive signal for operation is as below.

a) It is selected in Service mode.
b) It is selected in **Remote Mode.**
c) MCC Disturbed Signal from MCC.
d) Off Signal Feedback is available from MCC
e) No fire signal.
f) At least any one AHU is in running condition.

Now if all above permissive signals are available then FAF drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running AHU Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) FA Fan will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) FA fan will be tripped if DDCMIS receives Fire signal from Fire Fighting Panel.

Following are the **Status indication** details of FA Fan in OWS.

a) Respective FA fan running status will be displayed in Graphics as red color.
b) Respective FA fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.

STEP-3
(Cooling Tower Operation)

Select the Cooling Tower to start from respective POP in Graphics. Required 1 no. CT Fan is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system.

As soon as anyone CT Fan is selected for working, its Inlet line **motorized valve** will be also opened automatically.

Now **“Start”** command for any selected CT Fan can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in Service mode.
b) It is selected in Remote Mode.
c) CT Inlet valves open feedback available.
d) MCC Disturbed Signal from MCC.
e) At least any one DX-AHU is in running condition.

Now if all above permissive signals are available then CT Fan drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CT Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) CT fan will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) CT Fan will be tripped if tank water level becomes low for particular time (30 Seconds)
d) CT Fan will be stopped upon receiving of inlet valve close signal

Following are the **Status indication** details of CT Fan in OWS.

a) Respective CT fan running status will be displayed in Graphics as red color.
b) Respective CT fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics as amber color with alarm message.

STEP-4
Selection of Water Cooled Condensing Unit (WCCU)

Each DX-AHU will have its own dedicated Water Cooled Condensing Unit. On Selecting DX-AHU No. 1, dedicated Water Cooled Condensing Unit (WCCU) will automatically be selected for Working mode in OWS. Logic for same to be built in the system.

Rest one no is to be kept in **Standby mode** for auto Change over during auto operation of AC system.

As soon as any Water Cooled Condensing Unit is selected for working, its **Condenser water outlet line motorized valves** will be opened automatically

STEP-5
(Condenser Water Pump Operation)

Select the Condenser Water Pump (CWP) to start from respective POP in Graphics. Required 1 no. CWP is to be selected for **working mode** from OWS. Rest 1no is to be kept in **Standby mode** for auto Change over during auto operation of AC system. (Auto change over shall not be happened if standby Condenser Water Pump are kept in **maintenance mode**).

As soon as anyone CWP is selected for working, its outlet line **motorized valve** will be also opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

Now **"Start"** command for any selected CWP can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode.**
c) **CWP outlet Valve** open feedback available**.**
d) **Water Cooled Condensing Unit** Condenser Water Outlet Valve open feedback available.
e) **MCC Disturbed Signal from MCC.**
f) **At** least any one CT fan running condition.

Now if all above permissive signals are available then CWP drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CWP.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) CWP will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) CWP will be tripped immediately if Cooling Tower tank low level is available.
d) CWP will be tripped if pump outlet pressure is not developed within particular time (30 seconds) after running of Pump. Pump outlet pressure will be displayed in Graphics.
e) CWP will be stopped upon receiving of pump outlet valve close signal.
f) CWP will be stopped upon receiving of WCCU condenser water inlet valve close signal

Following are the **Status indication** details of CWP in OWS.

a) Respective CWP running status will be displayed in Graphics as red color with rotating movement.
b) Respective CWP off status will be displayed in Graphics as Green color with rotating movement.
c) Respective CWP Trip status will be displayed in Graphics as Amber Color with Alarm message.

STEP -6
(Water Cooled Condensing Unit operation (WCCU / DX UNIT))

It has been already stated in Step-4 that each Water Cooled Condensing Unit has its own dedicated DX-AHU. On Selecting DX-AHU, WCCU corresponding to it automatically gets selected as working and accordingly Condenser water outlet valves opened. Without opening those valves any Condenser Water Pump cannot be started.

Permissive signal for selected Chiller Machine will be as below.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode**
c) **Motorized valves** open signal at Condenser water outlet line of selected WCCU are available.
d) **Motorized valves** close signal at Condenser water outlet line of standby WCCU are available.
e) Any 1 no. Condenser Water Pumps is running.
f) Any 1 no. Cooling Tower is running.
g) Any one AHU is in running condition
h) Condenser Water Flow through WCCU is healthy (Signal from Flow switch)

If above permissive signals are available, then selected chiller machine can be started from OWS as well as WCCU Machine panel. **After giving start command by above, the Internal System of machine will be checked by its own dedicated control panel. If found ok, then selected WCCU machine will start.** Start indication & alarm will be shown at OWS & the stand by WCCU Machine is to be selected for operation & the same can be started as per above procedure.

Following **protection features** have been considered to trip the running Chiller Machine.

a) Chiller Machine shall trip if any of the start permissive signal is not satisfied.

DUCT HEATER & PAN HUMIDIFIER OPERATION

Duct heater or Pan Humidifier (both are provided inside AHU room) will be controlled & monitored automatically by the logic depending on the value of return **Air Temperature & RH Graphics**. **ON & OFF status** of respective heater & Pan Humidifier can be seen in Graphics. Pan Humidifier will be functioning at lower limit of RH while heaters will be functioning at upper limit of RH. Heater will be also functioning at lower value of temperature.

DUCT HEATER PERMISSIVE:

Duct heater has 3 steps - Duct heater **step-1** switches **ON** if return air temperature falls below **20ºC** and switches **OFF** if temperature rises above **22ºC**. Similarly, Duct heater step 2 & 3 switches ON if return air temperature falls below 18 ºC & 16ºC respectively and switches OFF if temperature rises above 20 ºC & 18ºC respectively. Safety thermostat, called Airstat, is provided on duct at heater outlet to trip heaters of all steps in case supply air temperature is abnormally high.

Heater will also maintain the RH in monsoon. If the RH value exceeds 55% (adjustable), then the

heater step-1 will start to maintain the RH at 50% (cut-off point). However, the heater will be stopped, if the temperature increases above 24 Deg C.

Other Start permissive for Duct Heater:

c) Heater Air Stat (Thermostat) is healthy (integral part of heater)
d) Duct air pressure is healthy

PAN HUMIDIFIER PERMISSIVE:

a) Return Air RH in AHU room is less than Reference set point (45%-adjustable) with Cut-off at 50% (adjustable)
b) Humidifier Gyserstat is healthy (Safety Thermostat Temperature is not high) (integral part of humidifier) -
c) Humidifier water level healthy (Water level in pan Humidifier is not low) (integral part of humidifier)

STEP -7
#FIRE DAMPER OPERATION

FIRE/SMOKE sensed by the FDA sensor installed in the Air Conditioning Area will send feedback to the FPS Control Panel which in turn send signal to DDCMIS for Air Conditioning System. Suitable no. of potential free contact shall be provided in the fire alarm panel by Fire Protection Supplier. On Receipt of fire signal, command from DDCMIS shall be generated for the closure of fire dampers to cut off the air supply to the affected area.

Simultaneously, run permissive for AHU, Fresh Air Fan shall be withdrawn and annunciation will be generated in the DDCMIS (AC Control System) panel.

In this process now the total system will be in operation & will continue to run if not stopped manually or by some fault.

8.0 AUTOMATIC START SEQUENCE

When **Auto mode** operation is selected in respective Graphics, the total system will wait further to receive **"Auto Start"** command and if it is done then system will run automatically in sequence as per the preset program in DDCMIS.

Before giving "**Auto Start"** command from Graphics, operator is to **select** desired drives in working mode which need to be started from Graphics of ESP Building.

Now "**Auto Start"** command can be given from Graphic and DDCMIS will immediately scan/check all interlocks (as explained in manual mode) and if found satisfactory will start all drives in the following sequentially.

AUTO START SEQUENCE STEP-1

AHU systems (Pre-selected) will start automatically in sequence. If any AHU fail to start or develops trouble during running, the standby AHU (if it is selected in Service and Standby mode) of that area will start automatically.

AUTO START SEQUENCE STEP-2

Fresh air fan of the respective AHU Room will also start automatically. If at least one AHU Fan Run feedback is available of respective AHU room.

AUTO START SEQUENCE STEP-3

Cooling Tower Fan selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected CT Fan are healthy as explained in manual mode. Under running condition if any CT Fan is tripped then standby CT Fan (subject to CT Fan is selected in Service and Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-4

Condenser Water Pump selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected Condenser Water Pump are healthy as explained in manual mode. Under running condition if any Condenser Water Pump is tripped then standby pump (subject to Pump is selected in Service and Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-5

- Based on the running feedback signal of the Condenser Water Pump, AHU and open & close feedback of motorized valves (Condenser water line of selected/non selected Water Cooled Condensing Unit) flow healthiness, Pressure healthiness feedback (details are mentioned in manual mode) selected Water Cooled Condensing Unit Will Start.

- When the AHU starts the duct heater or Pan Humidifier will also be controlled (on/off) & monitored by the DDCMIS depending on the value of RA temperature /RH with respect to the set point.

Operation of entire AC system as per above stated process will remain in running condition if not ''Auto Stop'' command is given from Graphics.

8.1 AUTOMATIC STOP SEQUENCE

Now "Auto Stop" command can be given from Graphic of ESP Building and DDCMIS will immediately Stop all drives in the following sequentially.

a) Water Cooled Condensing Unit will stop.
b) Condenser water pump will stop.
c) Cooling Tower will stop.
d) Fresh Air Fan will stop.
e) AHU will stop.

Hence Air-conditioning system of ESP Building will stop automatically.

To Stop the System manually, stop command to Air Conditioning Equipment shall be given in the sequence described above.

C) OPERATION & CONTROL OF AIRCONDITIONING SYSTEM OF SERVICE BUILDING

8.0 <u>DETAILED OPERATION OF DRIVES IN MANUAL MODE FOR SERVICE BUILDING.</u>
 # EQUIPMENT DETAILS OF AIR CONDITIONING SYSTEM OF SERVICE BUILDING

The AC system in Service Building area consists of the following major equipment's:

8.1 2 nos. Cooling Towers (1W+1S) are located at Terrace of Service Building.

8.2 2 nos. Condenser water pumps (1W+1S) are located at Terrace of Service Building.

8.3 2 nos. Makeup Water tanks are located at Terrace of Service Building.

8.4 8 Nos. PAC's are located at Ground Floor 0.0M of Service Building.
a) 4 nos. PAC's (2W+2S) are located at Ground Floor 0.0M Grid (AC-1,2) of Service Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Ground Floor 0.0M Grid (AC-1,2) of Service Building
c) 4 nos. PAC's (2W+2S) are located at Ground Floor 0.0M Grid(AC-8,9) of Service Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Ground Floor 0.0M Grid (AC-8,9) of Service Building

8.5 8 Nos. PAC's are located at First Floor 4.25M of Service Building.
a) 4 nos. PAC's (2W+2S) are located at First Floor 4.25M Grid (AC-1,2) of Service Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at First Floor 4.25M Grid (AC-1,2) of Service Building
c) 4 nos. PAC's (2W+2S) are located at First Floor 4.25M Grid(AC-8,9) of Service Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at First Floor 0.0M Grid (AC-8,9) of Service Building

8.6 8 Nos. PAC's are located at Second Floor 8.50M of Service Building.
a) 4 nos. PAC's (2W+2S) are located at Second Floor 8.50M Grid (AC-1,2) of Service Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Second Floor 8.50M Grid (AC-1,2) of Service Building
c) 4 nos. PAC's (2W+2S) are located at Second Floor 8.50M Grid(AC-8,9) of Service Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Second Floor 8.50M Grid (AC-8,9) of Service Building

8.7 8 Nos. PAC's are located at Third Floor 12.75M of Service Building.
a) 4 nos. PAC's (2W+2S) are located at Third Floor 12.75M Grid (AC-1,2) of Service Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Third Floor 12.75M Grid (AC-1,2) of Service Building
c) 4 nos. PAC's (2W+2S) are located at Third Floor 12.75M Grid(AC-8,9) of Service Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Third Floor 12.75M Grid (AC-8,9) of Service Building

8.8 8 Nos. PAC's are located at Fourth Floor 17.0M of Service Building.
a) 4 nos. PAC's (2W+2S) are located at Fourth Floor 17.0M Grid (AC-1,2) of Service Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Fourth Floor 17.0M (AC-1,2) of Service Building
c) 4 nos. PAC's (2W+2S) are located at Fourth Floor 17.0M Grid(AC-8,9) of Service Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors,

Fire Dampers etc. at Fourth Floor 17.0M Grid (AC-8,9) of Service Building

9.1 DETAILED OPERATION OF DRIVES IN MANUAL MODE FOR SERVICE BUILDING.

Now open the graphic of Service building and follow following steps for manual operation.

STEP-1
(Cooling Tower Operation)

Select the Cooling Tower to start from respective POP in Graphics. Required 1 no. CT Fan is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system.

As soon as anyone CT Fan is selected for working, its Inlet line **motorized valve** will be also opened automatically.

Now **"Start"** command for any selected CT Fan can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in Service mode.
b) It is selected in Remote Mode.
c) CT Inlet valves open feedback available.
d) MCC Disturbed Signal from MCC.

Now if all above permissive signals are available then CT Fan drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CT Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) CT fan will be tripped as soon as received of MCC Disturbed Signal from MCC.
c) CT Fan will be tripped if tank water level becomes low for particular time (30 Seconds)
d) CT Fan will be stopped upon receiving of inlet valve close signal

Following are the **Status indication** details of CT Fan in OWS.

a) Respective CT fan running status will be displayed in Graphics as red color.
b) Respective CT fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics as amber color with alarm message.

STEP-2
 # Selection of PACKAGE AC (PAC)

Required nos. PAC's are selected for **working mode** from OWS. Rest nos. are to be kept in **Standby mode** for auto Change over during auto operation of AC system. Package AC selection shall be done for all floors. The selection of working and standby PAC shall be as per above equipment detail mentioned for service building.

As soon as any PAC is selected for working, its motorized valve (**2 Way valve)** will be opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green

color (for Close status).

STEP-3

(Condenser Water Pump Operation)

Select the Condenser Water Pump (CWP) to start from respective POP in Graphics of Service building. Required 1 no. CWP is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system. (Auto change over shall not be happened if standby Condenser Water Pump are kept in **maintenance mode**).

As soon as anyone CWP is selected for working, its outlet line **motorized valve** will be also opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

Now **"Start"** command for any selected CWP can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode.**
c) **CWP outlet Valve** open feedback available**.**
d) **MCC Disturbed Signal from MCC.**
e) At least any one CT fan running condition.

Now if all above permissive signals are available then CWP drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CWP.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) CWP will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) CWP will be tripped immediately if Cooling Tower tank low level is available.
d) CWP will be tripped if pump outlet pressure is not developed within particular time (30 seconds) after running of Pump. Pump outlet pressure will be displayed in Graphics.
e) CWP will be stopped upon receiving of pump outlet valve close signal.

Following are the **Status indication** details of CWP in OWS.

a) Respective CWP running status will be displayed in Graphics as red color with rotating movement.
b) Respective CWP off status will be displayed in Graphics as Green color with rotating movement.
c) Respective CWP Trip status will be displayed in Graphics as Amber Color with Alarm message.

STEP -4

(PAC operation)

It has been already stated in Step-2 that PAC's working selection are to be done after running of Cooling Tower for opening 2Way valve (motorized valve at the condenser water line of package AC) corresponding to working PAC's. Without opening 2 Way valves any PAC cannot be started.

Permissive signal for PAC will be as below.

a) Motorized Valve (2Way valves) open feedback of respective PAC is available.
b) Any 1 no. Condenser Water Pumps is running.
c) Any 1 no. Cooling Tower is running.
d) Condenser Water Flow through PAC Machine is healthy (Signal from Flow switch)
e) No fire signal.
f) At least minimum one no or required nos. Fire Damper are open. This will be ensured by each damper Limit switch. Normally all Fire Dampers will remain open until main power supply is switched off or there is no fire signal in DDCMIS from Firefighting panel. All Dampers will be closed if fire signal is received in DDCMIS from Fire Fighting system. Closure of fire damper shall raise annunciation in the panel.

If above permissive signals are available, then selected PAC can be started from OWS. **After giving start command by above, the Internal System of machine will be checked by its own dedicated control panel. If found ok, then selected PAC will start.** Start indication & alarm will be shown at OWS. Standby PAC to be selected for operation and can be started as per above procedure.

Following **protection features** have been considered to trip the PAC.
a) All Condenser Water Pumps OFF feedback is available.
b) All Cooling Towers OFF feedback is available.
c) PAC will be tripped as soon as received of MCC Disturbed Signal from MCC. .

PAC provided in all Package AC Room (10 Rooms) to be operated as per above procedure.

STEP-4
(FRESH AIR FAN OPERATION)

2 No Fresh air fan (2W+0S) is provided inside each Package AC Room of Service Building. It will be started after running of any Package AC. Its Permissive signal for operation is as below.

a) It is selected in Service mode.
b) It is selected in **Remote Mode.**
c) MCC Disturbed Signal from MCC.
d) Off Signal Feedback is available from MCC
e) No fire signal.
f) At least any one PAC is in running condition.

Now if all above permissive signals are available then FAF drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running AHU Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) FA Fan will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) FA fan will be tripped if DDCMIS receives Fire signal from Fire Fighting Panel.

Following are the **Status indication** details of FA Fan in OWS.

a) Respective FA fan running status will be displayed in Graphics as red color.
b) Respective FA fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.

FAF provided in all Package AC Room (10 Rooms) to be operated as per above procedure.

STEP-5
 # DUCT HEATER & PAN HUMIDIFIER OPERATION

Duct heater or Pan Humidifier (both are provided inside AHU room) will be controlled & monitored automatically by the logic depending on the value of return **Air Temperature & RH Graphics**. **ON & OFF status** of respective heater & Pan Humidifier can be seen in Graphics. Pan Humidifier will be functioning at lower limit of RH while heaters will be functioning at upper limit of RH. Heater will be also functioning at lower value of temperature.

DUCT HEATER PERMISSIVE:

Duct heater has 3 steps - Duct heater **step-1** switches **ON** if return air temperature falls below **22ºC** and switches **OFF** if temperature rises above **24ºC**. Similarly, Duct heater step 2 & 3 switches ON if return air temperature falls below 20 ºC & 18ºC respectively and switches OFF if temperature rises above 22 ºC & 20ºC respectively. Safety thermostat, called Airstat, is provided on duct at heater outlet to trip heaters of all steps in case supply air temperature is abnormally high.

Heater will also maintain the RH in monsoon. If the RH value exceeds 55% (adjustable), then the heater step-1 will start to maintain the RH at 50% (cut-off point). However, the heater will be stopped, if the temperature increases above 26 Deg C.

Other Start permissive for Duct Heater:
a) Heater Air Stat (Thermostat) is healthy (integral part of heater)
b) Duct air pressure is healthy

PAN HUMIDIFIER PERMISSIVE:

a) Return Air RH in AHU room is less than Reference set point (45%-adjustable) with Cut-off at 50% (adjustable)
b) Humidifier Gyserstat is healthy (Safety Thermostat Temperature is not high) (integral part of humidifier) -
c) Humidifier water level healthy (Water level in pan Humidifier is not low) (integral part of humidifier)

STEP -6
#FIRE DAMPER OPERATION

FIRE/SMOKE sensed by the FDA sensor installed in the Air Conditioning Area will send feedback to the FPS Control Panel which in turn send signal to DDCMIS for Air Conditioning System. Suitable no. of potential free contact shall be provided in the fire alarm panel by Fire Protection Supplier. On Receipt of fire signal, command from DDCMIS shall be generated for the closure of fire dampers to cut off the air supply to the affected area.

Simultaneously, run permissive for AHU, Fresh Air Fan shall be withdrawn and annunciation will be generated in the DDCMIS (AC Control System) panel.

In this process now the total system will be in operation & will continue to run if not stopped manually or by some fault.

10.0 AUTOMATIC START SEQUENCE

When **Auto mode** operation is selected in respective Graphics, the total system will wait further to receive **"Auto Start"** command and if it is done then system will run automatically in sequence as per the preset program in DDCMIS.

Before giving "**Auto Start"** command from Graphics, operator is to **select** desired drives in working mode which need to be started from Graphics of Service Building.

Now "**Auto Start"** command can be given from Graphic and DDCMIS will immediately scan/check all interlocks (as explained in manual mode) and if found satisfactory will start all drives in the following sequentially.

AUTO START SEQUENCE STEP-1

Cooling Tower Fan selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected CT Fan are healthy as explained in manual mode. Under running condition if any CT Fan is tripped then standby CT Fan (subject to CT Fan is selected in Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-2

Condenser Water Pump selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected Condenser Water Pump are healthy as explained in manual mode. Under running condition if any Condenser Water Pump is tripped then standby pump (subject to Pump is selected in Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-3

- Based on the running feedback signal of the Condenser Water Pump & open feedback of 2Way valve of selected working PAC and all permissive (mentioned in manual mode) the selected PAC will start.

- When the PAC starts the duct heater or Pan Humidifier will also be controlled (on/off) & monitored by the DDCMIS depending on the value of RA temperature /RH with respect to the set point.

AUTO START SEQUENCE STEP-4

Fresh air fan of the respective PAC Room will also start automatically. If at least one PAC Run feedback is available of respective PAC room.

Operation of entire AC system as per above stated process will remain in running condition if not ''Auto Stop'' command is given from Graphics.

11.0 AUTOMATIC STOP SEQUENCE

Now **"Auto Stop"** command can be given from Graphic of Service Building and DDCMIS will immediately Stop all drives in the following sequentially.

a) Fresh Air Fan will stop.
b) All PAC will stop.
c) All Condenser Water Pump will stop.
d) All Cooling Tower will stop.

Hence Air-conditioning system of Service Building will stop automatically.

To Stop the System manually, stop command to Air Conditioning Equipment shall be given in the sequence described above.

D) OPERATION & CONTROL OF AIRCONDITIONING SYSTEM OF ADMIN BUILDING

12.0 DETAILED OPERATION OF DRIVES IN MANUAL MODE FOR ADMIN BUILDING.

 # EQUIPMENT DETAILS OF AIR CONDITIONING SYSTEM OF ADMIN BUILDING

The AC system in Admin Building area consists of the following major equipment's:

12.1 2 nos. Cooling Towers (1W+1S) are located at Terrace of Admin Building.

12.2 2 nos. Condenser water pumps (1W+1S) are located at Terrace of Admin Building.

12.3 2 nos. Makeup Water tanks are located at Terrace of Admin Building.

12.4 8 Nos. PAC's are located at Ground Floor 0.0M of Admin Building.

a) 4 nos. PAC's (2W+2S) are located at Ground Floor 0.0M Grid (FG-3,4) of Admin Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Ground Floor 0.0M Grid (FG-3,4) of Admin Building
c) 4 nos. PAC's (2W+2S) are located at Ground Floor 0.0M Grid (FG-9,11) of Admin Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at Ground Floor 0.0M Grid (FG-9,11) of Admin Building

12.5 8 Nos. PAC's are located at First Floor 4.25M of Admin Building.

a) 4 nos. PAC's (2W+2S) are located at First Floor 4.25M Grid (FG-3,4) of Admin Building
b) Accessories like 2-Way valves, Fresh Air Fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at First Floor 4.25M Grid (FG-3,4) of Admin Building
c) 4 nos. PAC's (2W+2S) are located at First Floor 4.25M Grid(FG-9,11) of Admin Building
d) Accessories like 2-Way valves, Fresh Air fan, Heaters, Pan Humidifier, Temperature & RH. Sensors, Fire Dampers etc. at First Floor 0.0M Grid (FG-9,11) of Admin Building

13.1 DETAILED OPERATION OF DRIVES IN MANUAL MODE FOR ADMIN BUILDING.

Now open the graphic of Admin building and follow following steps for manual operation.

STEP-1
(Cooling Tower Operation)

Select the Cooling Tower to start from respective POP in Graphics of Admin Building. Required 1 no. CT Fan is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system.

As soon as anyone CT Fan is selected for working, its Inlet line **motorized valve** will be also opened automatically.

Now **"Start"** command for any selected CT Fan can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in Service mode.
b) It is selected in Remote Mode.
c) CT Inlet valves open feedback available.
d) MCC Disturbed Signal from MCC.

Now if all above permissive signals are available then CT Fan drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CT Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as "drive fail to start".
b) CT fan will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) CT Fan will be tripped if tank water level becomes low for particular time (30 Seconds)
d) CT Fan will be stopped upon receiving of inlet valve close signal

Following are the **Status indication** details of CT Fan in OWS.

a) Respective CT fan running status will be displayed in Graphics as red color.
b) Respective CT fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics as amber color with alarm message.

STEP-2
 # Selection of PACKAGE AC (PAC)

Required nos. PAC's are selected for **working mode** from OWS. Rest nos. are to be kept in **Standby mode** for auto Change over during auto operation of AC system. Package AC selection shall be done for all floors. The selection of working and standby PAC shall be as per above equipment detail mentioned for Admin building.

As soon as any PAC is selected for working, its motorized valve (**2 Way valve)** will be opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

STEP-3
(Condenser Water Pump Operation)

Select the Condenser Water Pump (CWP) to start from respective POP in Graphics of Admin building. Required 1 no. CWP is to be selected for **working mode** from OWS. Rest 1 no. is to be kept in **Standby mode** for auto Change over during auto operation of AC system. (Auto change over shall not be happened if standby Condenser Water Pump are kept in **maintenance mode**).

As soon as anyone CWP is selected for working, its outlet line **motorized valve** will be also opened automatically. **Status indication** of Valves in Graphics shall be Red Color (for open status) & Green color (for Close status).

Now **"Start"** command for any selected CWP can be given from the Pop-Up Windows of respective drive after found following **permissive interlock** signal healthy.

.

a) It is selected in **Service Mode.**
b) It is selected in **Working Mode.**
c) **CWP outlet Valve** open feedback available**.**
d) **MCC Disturbed Signal from MCC.**
e) At least any one CT fan running condition.

Now if all above permissive signals are available then CWP drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running CWP.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) CWP will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) CWP will be tripped immediately if Cooling Tower tank low level is available.
d) CWP will be tripped if pump outlet pressure is not developed within particular time (30 seconds) after running of Pump. Pump outlet pressure will be displayed in Graphics.
e) CWP will be stopped upon receiving of pump outlet valve close signal.

Following are the **Status indication** details of CWP in OWS.

a) Respective CWP running status will be displayed in Graphics as red color with rotating movement.
b) Respective CWP off status will be displayed in Graphics as Green color with rotating movement.
c) Respective CWP Trip status will be displayed in Graphics as Amber Color with Alarm message.

STEP -4
(PAC operation)

It has been already stated in Step-2 that PAC’s working selection are to be done after running of Cooling Tower for opening 2Way valve (motorized valve at the condenser water line of package AC) corresponding to working PAC’s. Without opening 2 Way valves any PAC cannot be started.

Permissive signal for PAC will be as below.

a) Motorized Valve (2Way valves) open feedback of respective PAC is available.
b) Any 1 no. Condenser Water Pumps is running.
c) Any 1 no. Cooling Tower is running.
d) Condenser Water Flow through PAC Machine is healthy (Signal from Flow switch)
e) No fire signal.
f) At least minimum one no or required nos. Fire Damper are open. This will be ensured by each damper Limit switch. Normally all Fire Dampers will remain open until main power supply is switched off or there is no fire signal in DDCMIS from Firefighting panel. All Dampers will be closed if fire signal is received in DDCMIS from Fire Fighting system. Closure of fire damper shall raise annunciation in the panel.

If above permissive signals are available, then selected PAC can be started from OWS. **After giving start command by above, the Internal System of machine will be checked by its own dedicated control panel. If found ok, then selected PAC will start.** Start indication & alarm will be shown at OWS. Standby PAC to be selected for operation and can be started as per above procedure.

Following **protection features** have been considered to trip the PAC.
a) All Condenser Water Pumps OFF feedback is available.
b) All Cooling Towers OFF feedback is available.
c) PAC will be tripped as soon as received of MCC Disturbed Signal from MCC.

PAC provided in all Package AC Room (4 Rooms) to be operated as per above procedure.

STEP-4
(FRESH AIR FAN OPERATION)

2 No Fresh air fan (2W+0S) is provided inside each Package AC Room of Admin Building. It will be started after running of any Package AC. Its Permissive signal for operation is as below.

a) It is selected in Service mode.
b) It is selected in **Remote Mode.**
c) MCC Disturbed Signal from MCC.
d) Off Signal Feedback is available from MCC
e) No fire signal.
f) At least any one PAC is in running condition.

Now if all above permissive signals are available then FAF drive can be started from respective popup windows from graphics.

Following **protection features** have been considered to trip the running AHU Fan.

a) Start command from DDCMIS to MCC will be active only for few seconds (say 5 sec). However, alarm signal can be displayed on OWS as “drive fail to start”.
b) FA Fan will be tripped as soon as received of MCC Disturbed Signal from MCC. .
c) FA fan will be tripped if DDCMIS receives Fire signal from Fire Fighting Panel.

Following are the **Status indication** details of FA Fan in OWS.

a) Respective FA fan running status will be displayed in Graphics as red color.
b) Respective FA fan off status will be displayed in Graphics as Green color.
c) Trip status will be alarm message in Graphics.

FAF provided in all Package AC Room (10 Rooms) to be operated as per above procedure.

STEP-5
 # DUCT HEATER & PAN HUMIDIFIER OPERATION

Duct heater or Pan Humidifier (both are provided inside AHU room) will be controlled & monitored automatically by the logic depending on the value of return **Air Temperature & RH Graphics**. **ON & OFF status** of respective heater & Pan Humidifier can be seen in Graphics. Pan Humidifier will be functioning at lower limit of RH while heaters will be functioning at upper limit of RH. Heater will be also functioning at lower value of temperature.

DUCT HEATER PERMISSIVE:

Duct heater has 3 steps - Duct heater **step-1** switches **ON** if return air temperature falls below **22ºC** and switches **OFF** if temperature rises above **24ºC**. Similarly, Duct heater step 2 & 3 switches ON if return air temperature falls below 20 ºC & 18ºC respectively and switches OFF if temperature rises above 22 ºC & 20ºC respectively. Safety thermostat, called Airstat, is provided on duct at heater outlet to trip heaters of all steps in case supply air temperature is abnormally high.

Heater will also maintain the RH in monsoon. If the RH value exceeds 55% (adjustable), then the heater step-1 will start to maintain the RH at 50% (cut-off point). However, the heater will be stopped, if the temperature increases above 26 Deg C.

Other Start permissive for Duct Heater:

a) Heater Air Stat (Thermostat) is healthy (integral part of heater)
b) Duct air pressure is healthy

PAN HUMIDIFIER PERMISSIVE:

a) Return Air RH in AHU room is less than Reference set point (45%-adjustable) with Cut-off at 50% (adjustable)
b) Humidifier Gyserstat is healthy (Safety Thermostat Temperature is not high) (integral part of humidifier) -
c) Humidifier water level healthy (Water level in pan Humidifier is not low) (integral part of humidifier)

STEP -6
#FIRE DAMPER OPERATION

FIRE/SMOKE sensed by the FDA sensor installed in the Air Conditioning Area will send feedback to the FPS Control Panel which in turn send signal to DDCMIS for Air Conditioning System. Suitable no. of potential free contact shall be provided in the fire alarm panel by Fire Protection Supplier. On Receipt of fire signal, command from DDCMIS shall be generated for the closure of fire dampers to cut off the air supply to the affected area.

Simultaneously, run permissive for AHU, Fresh Air Fan shall be withdrawn and annunciation will be generated in the DDCMIS (AC Control System) panel.

In this process now the total system will be in operation & will continue to run if not stopped manually or by some fault.

14.0 AUTOMATIC START SEQUENCE

When **Auto mode** operation is selected in respective Graphics in Admin Building, the total system will wait further to receive **"Auto Start"** command and if it is done then system will run automatically in sequence as per the preset program in DDCMIS.

Before giving "**Auto Start"** command from Graphics, operator is to **select** desired drives in working mode which need to be started from Graphics of Admin Building.

Now "**Auto Start"** command can be given from Graphic and DDCMIS will immediately scan/check all interlocks (as explained in manual mode) and if found satisfactory will start all drives in the following sequentially.

AUTO START SEQUENCE STEP-1

Cooling Tower Fan selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected CT Fan are healthy as explained in manual mode. Under running condition if any CT Fan is tripped then standby CT Fan (subject to CT Fan is selected in Service and Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-2

Condenser Water Pump selected in working mode will start automatically in sequence subjected to all interlocks for the respective selected Condenser Water Pump are healthy as explained in manual mode. Under running condition if any Condenser Water Pump is tripped then standby pump (subject to Pump is selected in Service and Standby mode) will be started automatically after opening its motorized Butterfly valve.

AUTO START SEQUENCE STEP-3

- Based on the running feedback signal of the Condenser Water Pump & open feedback of 2Way valve of selected working PAC and all permissive (mentioned in manual mode) the selected PAC will start.

- When the PAC starts the duct heater or Pan Humidifier will also be controlled (on/off) & monitored by the DDCMIS depending on the value of RA temperature /RH with respect to the set point.

AUTO START SEQUENCE STEP-4

Fresh air fan of the respective PAC Room will also start automatically. If at least one PAC Run feedback is available of respective PAC room.

Operation of entire AC system as per above stated process will remain in running condition if not ''Auto Stop'' command is given from Graphics.

15.0 AUTOMATIC STOP SEQUENCE

Now **"Auto Stop"** command can be given from Graphic of Admin Building and DDCMIS will immediately Stop all drives in the following sequentially.

a) Fresh Air Fan will stop.
b) All PAC will stop.
c) All Condenser Water Pump will stop.
d) All Cooling Tower will stop.

Hence Air-conditioning system of Admin Building will stop automatically.

To Stop the System manually, stop command to Air Conditioning Equipment shall be given in the sequence described above.

16.0 LIST OF REFERENCE DOCUMENTS

(1) PID FOR MAIN POWER BUILDING FOR AC SYSTEM (PE-V0-412-553-A037).
(2) PID FOR ESP POWER BUILDING FOR AC SYSTEM (PE-V0-412-553-A037).
(3) PID FOR SERVICE POWER BUILDING FOR AC SYSTEM (PE-V0-412-553-A037).
(4) PID FOR ADMIN POWER BUILDING FOR AC SYSTEM (PE-V0-412-553-A037).
(5) DRIVE CONTROL PHILOSOPHY (PE-DM-412-145-I002)
(6) CONTROL SYSTEM FOR MECHANICAL AUXILIARY PACKAGES (PE-DM-412-145-I900)

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/Th&HyP/EE-7/M/ AEE/M/F.En SEZ STPP/D.739 /18 dt.15.12.2018.

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = IV

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
2018.11.28
17:20:02
+05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
27/11/2018	00	As per BHEL Comments	Alam	Salim	SKT
07/11/2017	A	First Submission	Vikas	Rajvir	PC

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A013**	Rev: **00**
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**Pressure Drop Calculation of chilled water & condenser water piping for AC**	

PROJECT:2x660 MW POWER PROJECT, Ennore

SUB: PRESSURE DROP CALCULATION FOR CONDENSER WATER PUMP FOR WATER COOLED CHILLER

LOCATION: CCR BUILDING

S.N	Description	Pipe Dia	Water Flow	Length of pipe	Bends			Gate Valve			Non-Return Valve			Balancing Valve			3-Way Control Valve			Y-Strainer			Mot. Gate Valve			Reducer/Tee			Total Eq. length	Friction factor	Total friction Head
					Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length			
		MM	GPM	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	ft	ft/100ft	ft
1	Pump In Connection	300	1350.0	15.00	3	19	57	1	13	13			0			0			0	1	164	164			0	1	13	13	262.00	1.33	3.48
2	Pump Out Connection	250	1350.0	6.00	0	0	0	1	12	12	1	98	98			0			0			0			0	1	13	13	129.00	2.30	2.97
3	From CDW Pump Header Up to Condenser Header	250	1350.0	60.00	6	16	96	0	12	0			0			0			0			0			0		0	0	156.00	2.30	3.59
4	Condenser In Connection	250	1350.0	16.00	1	16	16	1	12	12			0			0			0			0			0	1	40	40	84.00	2.30	1.93
5	Condenser Presure Drop						0		9	0			0			0			0			0			0		40	0	0.00	2.30	20.00
6	Condenser Out Connection	250	1350.0	13.00	1	16	16	1	9	9			0	1	278	278			0			0	1	12	12	1	11	11	339.00	2.30	7.80
7	From Condenser Header to Cooling Tower IN Header	250	1350.0	240.00	6	16	96		9	0			0			0			0			0			0	0	40	0	336.00	2.30	7.73
8	Cooling Tower In connections	250	1350.0	25.00	2	16	32		9	0			0			0			0			0	1	12	12	1	11	11	80.00	2.30	1.84
9	Static Discharge Head								9	0																					20.00
10	Cooling Tower Out Connections	300	1350.0	30.00	2	19	38	1	12	12			0			0			0			0			0	1	13	13	93.00	1.33	1.24
11	Cooling Tower Out Header to CDW Pump In Header	300	1350.0	240.00	10	19	190		12	0			0			0			0			0			0		50	0	430.00	1.33	5.72
				645.00																											

Note: 1.) Pressure drop across Valves, Bend, Reducer & Tee has been taken from CARRIER Handbook (attached).

2.) Friction factor across length of pipe has been taken from Carrier OPEN circuit piping chart graph(attached).

3.) Longest Piping Length has been taken from piping layout (Refer Attached Tetative Single Line Piping Layout).

4.) Formulae used; Total friction Head in ft. = [Total Eq. Length in ft. (Pipe+Valve +Fittings)/100] x Friction Loss (in ft/100 ft).

5.) Friction loss value mentioned above is for Schedule 40 Steel Pipe.

Head in Feet		**76.29**
Add Safety Margin@ 10%	**0.10**	**83.92**
Total Head in Feet		**83.92**
Total Head in Meters		**25.59**
Total Head in Meters (Selected)		**35.00**

PROJECT:2x660 MW POWER PROJECT, Ennore

SUB: PRESSURE DROP CALCULATION FOR CHILLED WATER PUMP FOR WATER COOLED CHILLER

LOCATION: CCR BUILDING

S.No	Description	Pipe Dia	Water Flow	Length of pipe	Bends			Gate Valve			Non-Return Valve			Balancing Valve			3-Way Control Valve			Y-Strainer			Mot. Gate Valve			Reducer/Tee			Total Eq. length	Friction factor	Total friction Head
					Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length			
		MM	GPM	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	ft	ft/100ft	ft
1	Pump In Connection	200	946.0	16.00	1	13	13	1	9	9			0			0			0	1	85	85			0	1	9	9	132.00	1.34	1.77
2	Pump Out Connection	200	946.0	16.00				1	9	9	1	80	80			0			0			0			0	1	9	9	114.00	1.34	1.53
3	From CHW Pump Header Up to Chiller Header	200	946.0	65.00	3	13	39		9	0			0			0			0			0			0			0	104.00	1.34	1.39
4	Chiller In Connection	200	946.0	13.00	1	13	13	1	9	9			0			0			0			0			0	0	0	0	35.00	1.34	0.47
5	Chiller(Evaporator) Presure Drop						0		9	0			0			0			0			0			0			0	0.00		20.00
6	Chiller Out Connection	200	946.0	13.00	1	13	13	0	0	0			0	1	203	203			0			0	1	9	9	0	0	0	238.00	1.34	3.19
7	From Chiller Header to Tee Point IN Plant At EL.+0.00M.	200	946.0	56.00		13	0		9	0			0			0			0			0			0				56.00	1.34	0.75
8	From Plant At EL.+0.00M. to Branch with Vertical Header in shaft TO 32.50M.	150	683.0	146.00	3	10	30		9	0			0			0			0			0			0	1	13	13	189.00	1.19	2.25
9	From Shaft 32.5m. to 24.00 m AHU Room	150	683.0	320.00	5	10	50	1	7	7			0			0			0			0			0			0	377.00	3.10	11.69
10	AHU In Connection	125	338.0	16.00	3	8	24	1	4	4			0			0			0	1	42	42			0	1	7	7	93.00	2.10	1.95
11	AHU Coil Pressure Drop						0			0			0			0			0			0			0			0	0.00		20.00
12	AHU Out Connection	125	338.0	16.00	3	10	30	1	4	4			0	1	141	141	1	10	10			0			0	1	7	7	208.00	2.10	4.37
13	From Shaft 32.5m. to 24.00 m AHU Room-R.	150	683.0	673.00	3	10	30	1	7	7			0			0			0			0			0	1	14	14	724.00	3.10	22.44
14	From Plant At EL.+0.00M. to Branch with Vertical Header in shaft TO 32.50M. - R.	150	683.0	100.00		20	0		9	0			0			0			0			0			0	1	18	18	118.00	3.10	3.66
										0																				
				1450.00									0																		

Note: 1.) Pressure drop across Valves, Bend, Reducer & Tee has been taken from ISHRAE Handbook (attached).

2.) Friction factor across length of pipe has been taken from ISHRAE CLOSED circuit piping chart graph(attached).

3.) Longest Piping Length has been taken from piping layout (Refer Attached Tetative Single Line Piping Layout).

4.) Formulae used; Total friction Head in ft. = [Total Eq. Length in ft. (Pipe+Valve +Fittings)/100] x Friction Loss (in ft/100 ft).

5.) Friction loss value mentioned above is for Schedule 40 Steel Pipe.

Head in Feet		**95.46**
Add Safety Margin@ 10%	**0.10**	**105.00**
Total Head in Feet		**105.00**
Total Head in Meters		**32.01**
Total Head in Meters (Selected)		**32.00**

PROJECT:2X660 MW NCC POWER PROJECT, ENNORE

SUB: PRESSURE DROP CALCULATION FOR Condenser WATER PUMP FOR PACKAGE AIR CONDITIONER

LOCATION: ESP BUILDING

S.N	Description	Pipe	Water	Length	Bends			Gate Valve			Non-Return Valve			Balancing Valve			3-Way Control Valve			Y-Strainer			Manual Gate Valve			Mot. Gate Valve			Reducer/Tee			Total	Friction	Total
		Dia	Flow	of pipe	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Eq. length	factor	friction Head
		MM	GPM	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	ft	ft/100ft	ft
1	Pump In Connection	100	132.0	7.00	1	7	7	0	4.5	0			0			0			0	1	46	46	1	5	5			0	1	4	4	64.00	1.60	1.02
2	Pump Out Connection	80	132.0	4.00	1	7	7		3.2	0	1	30	30			0			0			0			0	1	4	4	1	9	9	54.00	7.00	3.78
3	From CDW Pump Header Up to Condenser Header	80	132.0	30.00	3	5	15		3.2	0			0			0			0			0			0			0	0	15	0	45.00	7.00	3.15
4	Condenser In Connection (From 80mm Dia pipe)	40	132.0	3.00	0	5	0		3.2	0			0			0			0			0	0	3.2	0			0	0	15	0	3.00	30.00	0.90
5	Condenser in From Main Header of 80mm dia pipe	80	132.0	7.00	1	5	5		3.2	0			0			0			0			0	1	4	4			0	0	15	0	12.00	7.00	0.84
6	Condenser Pressure Drop					5	0		3.2	0			0			0			0			0			0			0		15	0	0.00		21.00
7	Condenser out Connection (To 80mm Dia pipe)	40	132.0	3.00	0	5	0		3.2	0			0			0			0			0	0	3.2	0			0	0	15	0	3.00	30.00	0.90
8	Condenser out To Main Header of 80mm dia pipe	80	132.0	7.00	1	5	5		3.2	0			0	1	85	85			0			0	0	4	0	1	4	4	0	15	0	101.00	7.00	7.07
9	From Condenser Header to Cooling Tower IN Header	80	132.0	110.00	6	5	30		3.2	0			0			0			0			0			0		3.2	0		15	0	140.00	7.00	9.80
10	Cooling tower In Connection (From 80mm Dia pipe)	50	132.0	2.00	1	3	3		3.2	0			0			0			0			0	0	3.2	0			0	1	3	3	8.00	28.00	2.24
11	cooling tower in From Main Header of 80mm dia pipe	80	132.0	12.00	1	5	5		3.2	0			0			0			0			0	0	4	0	1	4	4	2	5	10	31.00	7.00	2.17
12	Static Discharge Head	100	132.0			6.7	0		4.5	0			0			0			0			0			0			0	1	21	21	21.00	1.60	0.34
13	Cooling Tower Out Header to CDW Pump In Header	100	132.0	128.00	6	8	48		4.5	0			0			0			0			0			0			0	1	4	4	180.00	1.60	2.88
													0																					

Note: 1.) Pressure drop across Valves, Bend, Reducer & Tee has been taken from CARRIER Handbook (attached).

2.) Friction factor across length of pipe has been taken from Carrier OPEN circuit piping chart graph(attached).

3.) Longest Piping Length has been taken from piping layout (Refer Attached Tetative Single Line Piping Layout).

4.) Formulae used; Total friction Head in ft. = [Total Eq. Length in ft. (Pipe+Valve +Fittings)/100] x Friction Loss (in ft/100 ft).

5.) Friction loss value mentioned above is for Schedule 40 Steel Pipe.

Head in Feet		**56.09**
Add Safety Margin@ 10%	**0.10**	**61.70**
Total Head in Feet		**61.70**
Total Head in Meters		**18.81**
Total Head in Meters (Selected)		**25.00**

PROJECT:2X660 MW NCC POWER PROJECT, ENNORE

SUB: PRESSURE DROP CALCULATION FOR Condenser WATER PUMP FOR PACKAGE AIR CONDITIONER

LOCATION: ADMIN BUILDING

S.N	Description	Pipe	Water	Length	Bends			Gate Valve			Non-Return Valve			Balancing Valve			3-Way Control Valve			Y-Strainer			Mot.Gate Valve			Reducer/Tee			Total	Friction	Total
		Dia	Flow	of pipe	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Eq. length	factor	friction Head
		MM	GPM	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	ft	ft/100ft	ft
1	Pump In Connection	200	660.0	16.00	0	20	0	1	9	9			0			0			0	1	85	85			0	1	9	9	119.00	1.35	1.61
2	Pump Out Connection	150	660.0	16.00			0	0	0	0	1	60	60			0			0			0	1	7	7	1	30	30	113.00	6.00	6.78
3	From CDW Pump Header 8.45m Up to Condenser Header 0.00	125	387.0	110.00	4	8	32	2	6	12			0			0			0			0			0	1	12	12	166.00	3.50	5.81
4	Condenser In Connection	65	97.0	20.00	2	4	8			0			0			0			0			0	1	3	3	0	0	0	31.00	9.00	2.79
5	Condenser Presure Drop	65	97.0				0			0			0			0			0			0			0			0	0.00		21.00
6	Condenser Out Connection	65	97.0	20.00	2	4	8	1	3	3			0	1	69	69			0			0	0	0	0	0	0	0	100.00	9.00	9.00
7	From Condenser Header at 0.0 m to Condenser Header IN Header 8.45 m	150	660.0	53.30	2	7.5	15			0			0			0			0			0	1		0	0	7	0	68.30	9.00	6.15
8	Cooling Tower In connections	200	660.0	20.00	1	20	20			0			0			0			0			0	1	9	9	0	0	0	49.00	6.00	2.94
9	Static Discharge Head																														15.00
10	Cooling Tower Out Connections	200	660.0	10.00	1	20	20	1	9	9			0			0			0			0			0	0	0	0	39.00	1.35	0.53
11	Cooling Tower Out Header to CDW Pump In Header	200	660.0	82.00	2	20	40			0			0			0			0			0			0			0	122.00	1.35	1.65
													0																		

Note: 1.) Pressure drop across Valves, Bend, Reducer & Tee has been taken from CARRIER Handbook (attached).

2.) Friction factor across length of pipe has been taken from Carrier OPEN circuit piping chart graph(attached).

3.) Longest Piping Length has been taken from piping layout (Refer Attached Tetative Single Line Piping Layout).

4.) Formulae used; Total friction Head in ft. = [Total Eq. Length in ft. (Pipe+Valve +Fittings)/100] x Friction Loss (in ft/100 ft).

5.) Friction loss value mentioned above is for Schedule 40 Steel Pipe.

Head in Feet		**73.25**
Add Safety Margin@ 10%	**0.10**	**80.57**
Total Head in Feet		**80.57**
Total Head in Meters		**24.56**
Total Head in Meters (Selected)		**30.00**

PROJECT:2X660 MW NCC POWER PROJECT, ENNORE

SUB: PRESSURE DROP CALCULATION FOR Condenser WATER PUMP FOR PACKAGE AIR CONDITIONER

LOCATION:SERVICE BUILDING

S.N	Description	Pipe	Water	Length	Bends			Gate Valve			Non-Return Valve			Balancing Valve			3-Way Control Valve			Y-Strainer			Mot.Gate Valve			Reducer/Tee			Total	Friction	Total
		Dia	Flow	of pipe	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Qty	Eq. length	Total eq. length	Eq. length	factor	friction Head
		MM	GPM	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	Nos.	ft	ft	ft	ft/100ft	ft
1	Pump In Connection	300	1540.0	88.00	0	34	0	1	13	13			0			0			0	1	131	131	1	13	13	1	13	13	258.00	0.80	2.06
2	Pump Out Connection	200	1540.0	180.00	6	20	120	4	10	40	1	80	80			0			0	1	85	85			0	1	10	10	515.00	2.00	10.30
3	From CDW Pump Header Up to Condenser Header 17.00 m	200	836.0	206.00		20	0			0			0			0			0			0			0		18	0	206.00	2.00	4.12
4	From CDW Header 17.00m Up to Condenser Header 12.75m	150	572.0	15.00			0			0			0			0			0			0			0		18	0	15.00	1.30	0.20
5	From CDW Header 12.75m Up to Condenser Header 8.5m	125	440.0	13.12			0			0			0			0			0			0			0	1	14	14	27.12	3.00	0.81
6	From CDW Header 8.5m Up to Condenser Header 4.25 m	125	308.0	13.12			0			0			0			0			0			0			0	1	12	12	25.12	3.00	0.75
7	From CDW Header 4.25m Up to Condenser Header 0.0m	100	176.0	14.00	1	10	10	1	5	5	1	40	40	1	121	121	2	10	20			0	1	5	5	4	9	36	251.00	3.00	7.53
8	Condenser In Connection	65	88.0	29.52	4	4.1	16.4	1	2.8	2.8			0			0			0			0			0	1	5.6	5.6	54.32	6.50	3.53
9	Condenser Presure Drop	65	88.0							0			0			0			0			0			0			0	0.00		21.00
10	Condenser Out Connection	65	88.0	29.52	4	4.1	16.4	1	2.8	2.8			0	1	69	69			0			0	1	2.8	2.8	1	5.6	5.6	126.12	6.50	8.20
11	From CDW Header 4.25m Up to Condenser Header 0.0m	100	176.0	14.00	2	6.7	13.4			0			0			0			0			0			0	1	9	9	36.40	3.00	1.09
12	From CDW Header 8.5m Up to Condenser Header 4.25 m	125	308.0	13.12			0			0			0			0			0			0			0	1	12	12	25.12	3.00	0.75
13	From CDW Header 12.75m Up to Condenser Header 8.5m	125	484.0	13.12			0			0			0			0			0			0			0	1	14	14	27.12	3.00	0.81
14	From CDW Header 17.00m Up to Condenser Header 12.75m	150	660.0	15.00			0			0			0			0			0			0			0	1	18	18	33.00	1.30	0.43
15	From Cooling Tower Header Up to Condenser Header 17.00 m	200	836.0	271.00	2	20	40			0			0			0			0			0			0	1	18	18	329.00	2.00	6.58
16	Static Discharge Head																														25.00
				914.52									0																		

Note: 1.) Pressure drop across Valves, Bend, Reducer & Tee has been taken from CARRIER Handbook (attached).

2.) Friction factor across length of pipe has been taken from Carrier OPEN circuit piping chart graph(attached).

3.) Longest Piping Length has been taken from piping layout (Refer Attached Tetative Single Line Piping Layout).

4.) Formulae used; Total friction Head in ft. = [Total Eq. Length in ft. (Pipe+Valve +Fittings)/ 100] x Friction Loss (in ft/100 ft).

5.) Friction loss value mentioned above is for Schedule 40 Steel Pipe.

Head in Feet		**93.17**
Add Safety Margin@ 10%	**0.10**	**102.49**
Total Head in Feet		**102.49**
Total Head in Meters		**31.25**
Total Head in Meters (Selected)		**32.00**

Chart 2 - Friction Loss for Open Piping Systems (Water)

Schedule 40 Pipe

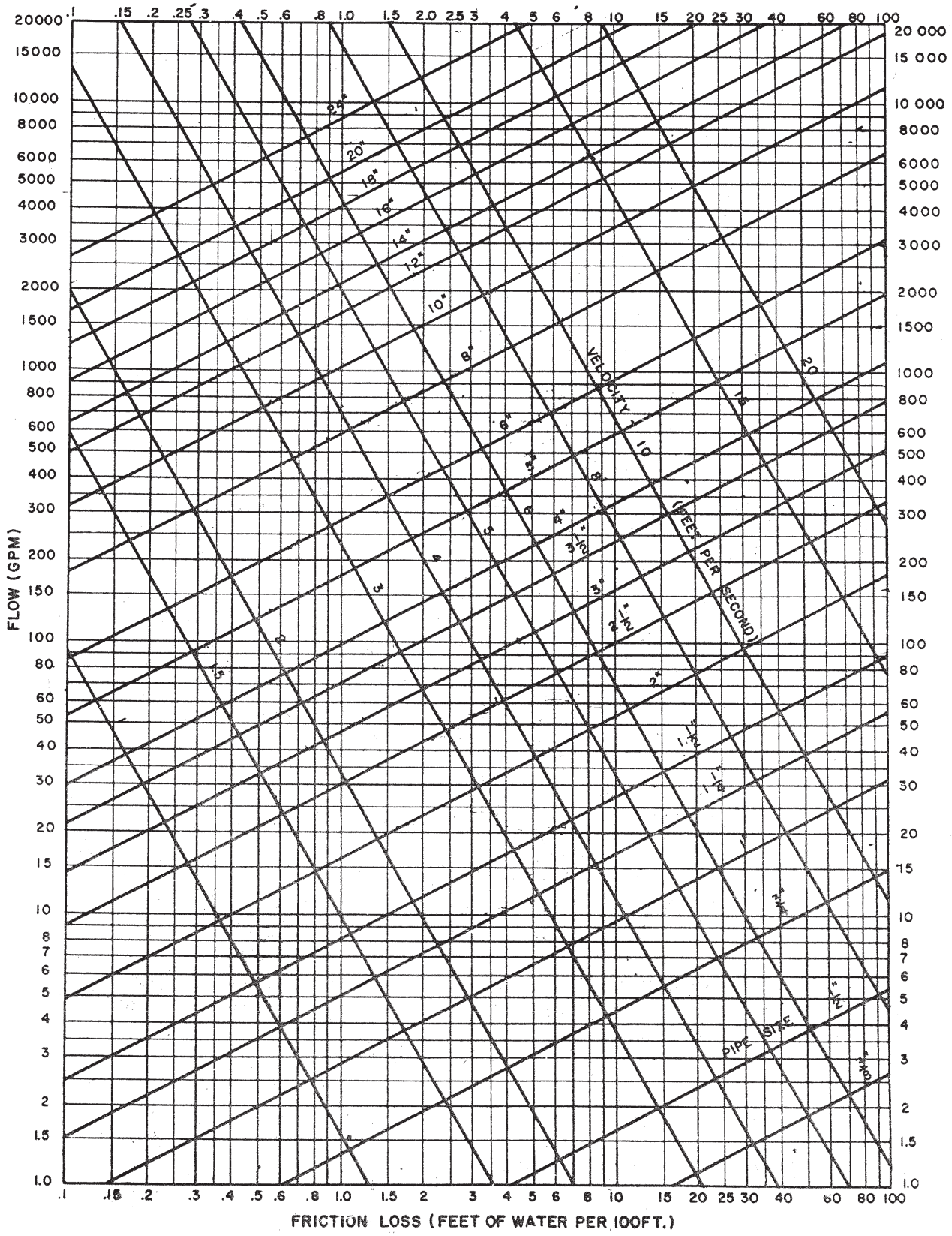


Chart 1 - Friction Loss for Closed Piping Systems (Water)

Schedule 40 Pipe

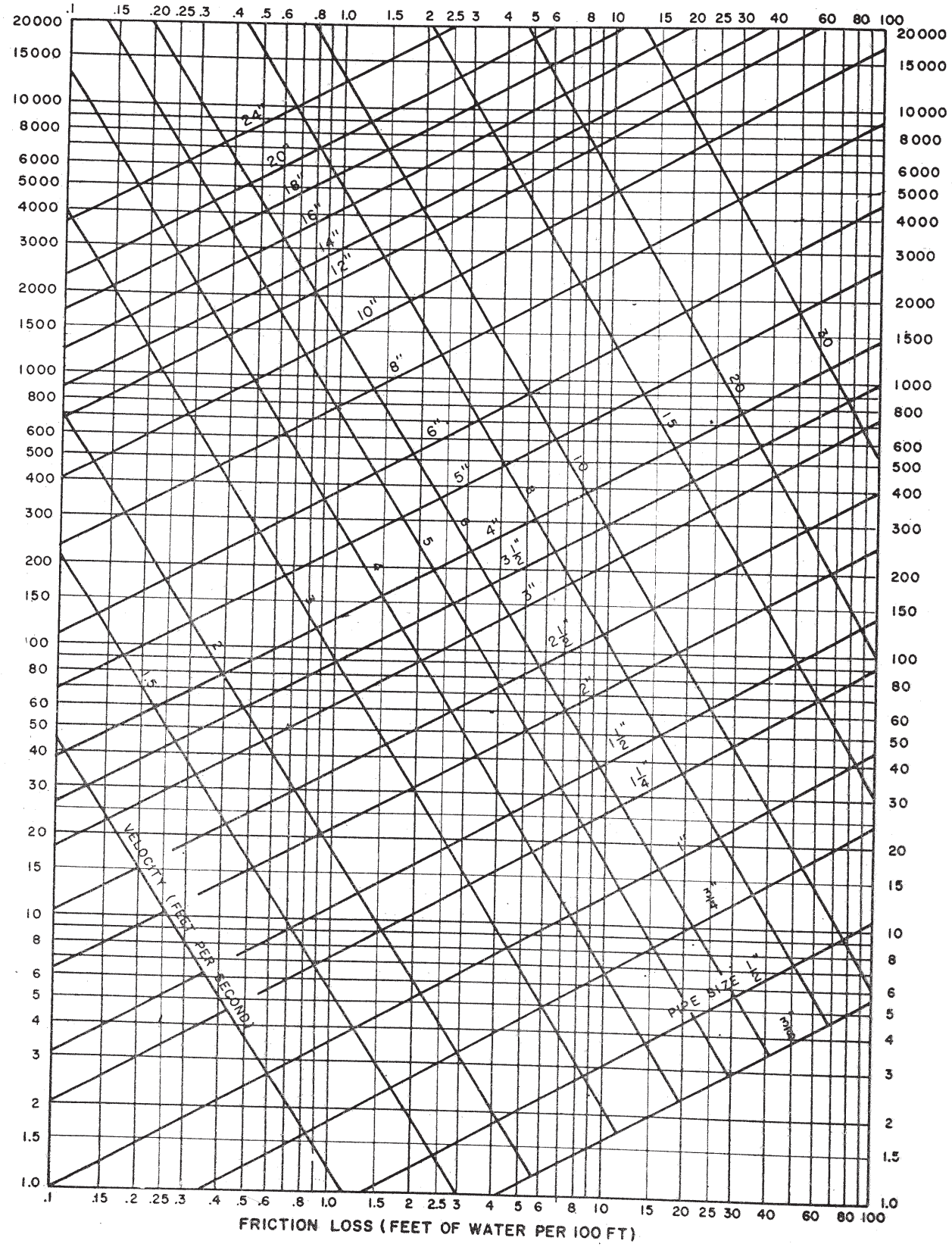
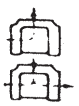
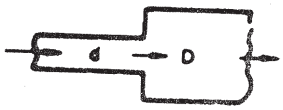
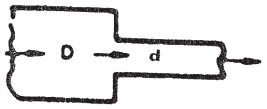
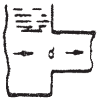


Table 6 Fitting Losses in Equivalent Metres of Pipe (Screwed, Welded Flanged, Flared, and Brazed Connection)

Nominal Pipe or Tube Size, mm	Smooth Bend Elbows						Smooth Bend Tees			
	90° Std[a]	90° Long Rad.[b]	90° Street[a]	45° Std[a]	45° Street[a]	180° Std[a]	Flow Through Branch	Straight-Through Flow		
								NO Reduction	Reduced 1/4	Reduced 1/2
										
10	0.4	0.3	0.7	0.2	0.3	0.7	0.8	0.3	0.4	0.4
15	0.5	0.3	0.8	0.2	0.4	0.8	1.9	0.3	0.4	0.5
20	0.6	0.4	1.0	0.3	0.5	1.0	1.2	0.4	0.6	0.6
25	0.8	0.5	1.2	0.4	0.6	1.2	1.5	0.5	0.7	0.8
32	1.0	0.7	1.7	0.5	0.9	1.7	2.1	0.7	0.9	1.0
40	1.2	0.8	1.9	0.6	1.0	1.9	2.4	0.8	1.1	1.2
50	1.5	1.0	2.5	0.8	1.4	2.5	3.0	1.0	1.4	1.5
65	1.8	1.2	3.0	1.0	1.6	3.0	3.7	1.2	1.7	1.8
80	2.3	1.5	3.7	1.2	2.0	3.7	4.6	1.5	2.1	2.3
90	2.7	1.8	4.6	1.4	2.2	4.6	5.5	1.8	2.4	2.7
100	3.0	2.0	5.2	1.6	2.6	5.2	6.4	2.0	2.7	3.0
125	4.0	2.5	6.4	2.0	3.4	6.4	7.6	2.5	3.7	4.0
150	4.9	3.0	7.6	2.4	4.0	7.6	9	3.0	4.3	4.9
200	6.1	4.0	—	3.0	—	10	12	4.0	5.5	6.1
250	7.6	4.9	—	4.0	—	13	15	4.9	7.0	7.6
300	9.1	5.8	—	4.9	—	15	18	5.8	7.9	9.1
350	10	7.0	—	5.5	—	17	21	7.0	9.1	10
400	12	7.9	—	6.1	—	19	24	7.9	11	12
450	13	8.8	—	7.0	—	21	26	8.8	12	13
500	15	10	—	7.9	—	25	30	10	13	15
600	18	12	—	9.1	—	29	35	12	15	18

[a] *R/D approximately* equal to 1.
[b] *R/D approximately* equal to 1.5

Table 7 Special Fitting Losses in Equivalent Metres of Pipe

Nominal Pipe or Tube Size, mm	Sudden Enlargement, d/D			Sudden Contraction, d/D			Sharp Edge		Pipe Projection	
	1/4	1/2	3/4	1/4	1/2	3/4	Entrance	Exit	Entrance	Exit
										
10	0.4	0.2	0.1	0.2	0.2	0.1	0.5	0.2	0.5	0.3
15	0.5	0.3	0.1	0.3	0.3	0.1	0.5	0.3	0.5	0.5
20	0.8	0.5	0.2	0.4	0.3	0.2	0.9	0.4	0.9	0.7
25	1.0	0.6	0.2	0.5	0.4	0.2	1.1	0.5	1.1	0.8
32	1.4	0.9	0.3	0.7	0.5	0.3	1.6	0.8	1.6	1.3
40	1.8	1.1	0.4	0.9	0.7	0.4	2.0	1.0	2.0	1.5
50	2.4	1.5	0.5	1.2	0.9	0.5	2.7	1.3	2.7	2.1
65	3.0	1.9	0.6	1.5	1.2	0.6	3.7	1.7	3.7	2.7
80	4.0	2.4	0.8	2.0	1.5	0.8	4.3	2.2	4.3	3.8
90	4.6	2.8	0.9	2.3	1.8	0.9	5.2	2.6	5.2	4.0
100	5.2	3.4	1.2	2.7	2.1	1.2	6.1	3.0	6.1	4.9
125	7.3	4.6	1.5	3.7	2.7	1.5	8.2	4.3	8.2	6.1
150	8.8	6.7	1.8	4.6	3.4	1.8	10	5.8	10	7.6
200	—	7.6	2.6	—	4.6	2.6	14	7.3	14	10
250	—	9.8	3.4	—	6.1	3.4	18	8.8	18	14
300	—	12.4	4.0	—	7.6	4.0	22	11	22	17
350	—	—	4.9	—	—	4.9	26	14	26	20
400	—	—	5.5	—	—	5.5	29	15	29	23
450	—	—	6.1	—	—	6.1	35	18	35	27
500	—	—	—	—	—	—	43	21	43	33
600	—	—	—	—	—	—	50	25	50	40

Note: Enter table for losses at smallest diameter *d*.

e 8 Suggested Hanger Spacing and Rod Size for Straight Horizontal Runs

	Hanger Spacing, ft			
	Standard Steel Pipe[a]		Copper Tube	Rod Size,
	Water	Steam	Water	in.
	7	8	5	1/4
	7	9	5	1/4
	7	9	6	1/4
2	9	12	8	3/8
	10	13	8	3/8
2	11	14	9	3/8
	12	15	10	3/8
	14	17	12	1/2
	17	21	14	1/2
	19	24	16	5/8
	20	26	18	3/4
	23	30	19	7/8
	25	32		1
	27	35		1
	28	37		1-1/4
	30	39		1-1/4

cing does not apply where span calculation are made or where ntrated loads are placed between supports such as flanges, , specialties, etc.

Table 9 Valve Losses in Equivalent Metres of Pipe

Nominal Pipe or Tube size, mm	Globe[a]	60°-Y	45°-Y	Angle[a]	Gate[b]	Swing Check[c]	Lift Check
10	5.2	2.4	1.8	1.8	0.2	1.5	
15	5.5	2.7	2.1	2.1	0.2	1.8	Globe
20	6.7	3.4	2.1	2.1	0.3	2.2	and
25	8.8	4.6	3.7	3.7	0.3	3.0	vertical
32	12	6.1	4.6	4.6	0.5	4.3	lift
40	13	7.3	5.5	5.5	0.5	4.9	same
50	17	9.1	7.3	7.3	0.73	6.1	as
65	21	11	8.8	8.8	0.9	7.6	globe
80	26	13	11	11	1.0	9.1	valve
90	30	15	13	13	1.2	10	
100	37	18	14	14	1.4	12	
125	43	22	18	18	1.8	15	
150	52	27	21	21	2.1	18	
200	62	35	26	26	2.7	24	Angle
250	85	44	32	32	3.7	30	lift
300	98	50	40	40	4.0	37	same
350	110	56	47	47	4.6	41	as
400	125	64	55	55	5.2	46	angle
450	140	73	61	61	5.8	50	valve
500	160	84	72	72	6.7	61	
600	186	98	81	81	7.6	73	

Table 10 Fouling Factors

Recommended minimum fouling allowances (f) for water flowing at 3 ft/sec[b] or higher:		
		ft².h.°F/(Btu)
Distilled Water		0.0005
Water, closed system		0.0005
Water, open system		0.0010
Inhibited cooling tower		0.0015
Engine jacket		0.0015
Treated boiler feed (212 F)		0.0015
Hard well water		0.0030
Untreated cooling tower		0.0033
am:		
Dry, clean and oil free		0.0003
wet, clean and oil free		0.0005
Exhaust from turbine		0.0010
	Non-ferrous tubes	**Ferrous tubes**
ines:		
Methylene Chloride	none	none
Inhibited Salts	0.0005	0.0010
Non-inhibited salts	0.0010	0.0020
Inhibited glycols	0.0010	0.0020
pours and gases:		
Refrigerant vapours		none
Solvent vapours		0.0008
Air, (clean) centrifugal comp		0.0015
Air, recifprocating compressor		0.0030
her liquids:		
Organic solvents (clean)		0.0001
Vegetable oils		0.0040
Quenching oils (filtered)		0.0050
Fuel oils		0.0060
Sea water		0.0005

ower velocities require higher f values.

Hardness of Water

Water supplies may be divided into four groups expressed as parts per million of Calcium Carbonate.

Class A : Less than 60 - Soft
Class B : 60 - 120 - Medium
Class C : 120 - 180 - Hard
Class D : Above 180 - Very Hard

Class C & D generally require softenig treatment.

pH - is a measure of acidity. pH is negative logarithm, base 10 of the concentration of the hydrogen - ions, in gms / litre. Water having a pH of 7.0 is exactly neutral: a pH less than 7 is acid; while a pH greater than 7 is alkaline. Water having a pH of 6 is mildly acid and any figure below 5 is considered distinctly acid and quite corrosive to ordinary metals. Natural unpolluted water usually have pH values between 7 & 8.5.

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/Th&HyP/ EE-7/M/AEE/M/F.En SEZ STPP/D.26 /19 dt.10.05.2019

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Revised as per TANGEDCO / Desein Comments. Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2019.01.03 15:11:41 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
19/12/2018	01	As per BHEL Comments	ALAM	SALIM	SKT
02/11/2018	0A	Second Submission	ALAM	SALIM	SKT
05/09/2018	00	First Submission	ALAM	SALIM	PC
04/08/2018	A	First Submission	ALAM	SALIM	PC

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A014**	Rev: 01
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**TDS & GA of Screw Chiller along with foundation details**	

SL.NO.	ITEM	Unit	DETAILS
1	**CHILLING UNIT DATA**		
a	Name & address of the manufacturer		Kirloskar Chillers Pvt. Ltd. Saswad, Pune.
b	Make & Model		Kirloskar Chillers & KWE 330.24
c	Number of equipment	No	Two
d	Installation		Indoor
e	Duty Type		Continuous
f	Nominal Capacity	TR	330
g	Actual Capacity (at operating conditions)	TR	306.9
h	Operating Weight / Shipping Weight	Kg	6680/7080 kg
i	Refrigerant		
	i) Name		R-134a
	ii) Quantity	Kg	244
j	Type of Condenser Cooling		Water Cooled
k	No. of Stages		Single
l	Mode of Start		Star Delta Starter
m	No. of Starts		Four per hour
n	Overall Dimensions (L X W X H)	mm	4560 X 1800 X 2400
o	Tube Cleaning Space Required	mm	3800
p	Type of Capacity Control		Slide Valve Mechanism
q	Range of Capacity Variation		100 to 12.5 % (Stepless)
r	Type of Bearing		Rolling Element
s	Type of Vibration Isolation		Neoprene Serrated Rubber Pads (efficiency > 85%)
t	Reference Standard		AHRI Standard 550/590
u	Power Supply		415V(+/- 10%), 50Hz (+/- 3%) , 3Ph, 4 Wire AC Supply, Client to provide One source of power supply for each chiller.
v	Isolator Switch & BMS		Fuses & MODBUS card Provided
w	Potential free contact for BMS		Provided
x	Type of Starter		Star Delta
y	Cable Size (Client scope) recommended		2 runs of 3.5 CoreX 185 sqmm, , **Al.** armored
z	Type of Expansion Valve		Electronic Expansion Valve
2	**COMPRESSOR**		
a	No. of Compressor		Two
b	Type of Compressor		Semi Hermetic Screw
c	Make of Compressor		Kirloskar
d	Model of Compressor		KXH 93 160 810Y - 1 No. & KXH 93 160 702Y - 1No.
e	Motor Rating to Each Compressor	kW	120 KW.
f	Operating Speed	RPM	2900
g	Rated load current (RLA)	amp	346 A (ie. 184A & 162A)

h	Starting Current Motor	amp	564A
i	Guaranteed Power Consumption at rated duty point (measured at motor input terminals) per Chilling Machine @ 100% load	ikW	212
j	Power Consumption ikw / TR with AHRI relief		
	100%	ikW/TR	0.69
	75%	ikW/TR	0.53
	50%	ikW/TR	0.46
	25%	ikW/TR	0.62
k	Catalogue enclosed		Yes
l	COP at AHRI condition		5.6
m	Condensing temperature	deg. C	39
n	Evaporating temperature	deg. C	5.1
o	Grade of lubrication oil		Synthetic oil,
p	Lubrication oil charge	Ltr	60 Ltr (ie. 30 each compressor)
3	**CONDENSER**		
a	Manufacturer		KCPL
b	Quantity per Chilling Machine		One
c	Type		Water cooled Shell & Tube flooded
d	No. of Passes (On water side)		Two
e	Shell Material		MS
f	Shell Outer Diameter	mm	510
g	Shell thickness	mm	8
h	Shell Length (Including Tube sheets)	mm	3630
i	Tube sheet Material		MS
j	Tube Material		Replaceable Seamless Copper tubes
k	Tube Size (diameter at plain end)	mm	18.92 (+/- 0.08)
l	Type of fins		Integrally & Externally finned
m	Tube thickness (plain end)	mm	0.99 (+/- 0.08)
n	Fin material		Cu
o	Tube Sheet Thickness (Finish)	mm	36
p	Fluid - Tube side		Water
q	Fluid - Shell side		Refrigerant
r	Water Flow	CMH	277.45
s	Water velocity	m/sec	< 3 m/sec
t	Pressure Drop through Condenser	bar	0.95
u	Water IN/OUT Temperature	deg. C	32 / 36
v	Differential temperature	deg. C	4
w	Fouling Factor	MKS	≤ 0.0002
x	Nozzle Size of In / Out of Water	NB	150 NB
y	Design pressure		10.3 Bar (water side) & 16 Bar (ref. side)
z	Operating pressure		9.4 Bar (water side) & 14.5 Bar (ref. side)

aa	Condenser Capacity	Kcal / hr	1109789
ab	Degree of sub cooling	Deg. C	4
4	**EVAPORATOR (CHILLER)**		
a	Manufacturer		KCPL
b	Quantity per Chilling Machine		One
c	Type		Water cooled Shell & Tube flooded
d	No. of Passes (On water side)		Two
e	Shell & tube Sheet Material		MS
f	Shell Outer Diameter	mm	610
g	Shell thickness	mm	8
h	Shell Length (Including Tube sheets)	mm	3630
i	Tube Material		Replaceable Seamless Copper tubes
j	Tube Size (diameter at plain end)	mm	18.92 (+/- 0.08)
k	Type of fins		Integrally & Externally finned
l	Tube thickness (plain end)	mm	1.08 (+/- 0.08)
m	Tube Sheet Thickness (Finish)	mm	42
n	Fluid - Tube side		Water
o	Fluid - Shell side		Refrigerant
p	Water Flow	CMH	208.7
q	Water velocity	m/sec	< 3 m/sec
r	Chilled Water IN/OUT Temperature	deg.C	11.1 / 6.7
s	Pressure Drop through Chiller	bar	1.01
u	Differential temperature	deg. C	4.4
v	Fouling Factor	MKS	≤ 0.0001
w	Evaporator Nozzle Size of In / Out of Water	NB	200 NB
x	Design pressure		10.3 Bar (water side) & 13 Bar (ref. side)
y	Operating pressure		9.4 Bar (water side) & 12 Bar (ref. side)
z	Evaporator Capacity	Kcal / hr	928050
aa	Degree of Super heating	Deg. C	2
5	**TESTING PRESSURE**		**Duration 4 hrs**
a	CONDENSER		
	i)Water Side (Hydraulic Test)	kg/cm2	13.7
	ii)Refrigerant Side (Pneumatic Test)	kg/cm2	17.9
b	EVAPORATOR (CHILLER)		
	i)Water Side (Hydraulic Test)	kg/cm2	13.7
	ii)Refrigerant Side (Pneumatic Test)	kg/cm2	14.6
6	**INSULATION**		
a	Material		Nitrile Foam
b	Insulation Thickness on Evaporator	mm	32
7	**G A & Foundation detail Drawing**		Enclosed(Drg No: 17.330.24.111.01.01, R00)
8	**Inspection & Testing**		As per approved QAP

9	**Paint**		
a	Shade		RAL 7035
b	Painting Details		PRIMER, TYPE- EPOXY PRIMER, SHADE- GRAY, SUPPLIER PART CODE- ULTRACORR MASTIC 150, MAKE- NANOVA CARE COAT. PAINT, TYPE- ACRYLIC POLYSILOXANE, FINISH- SMOOTH GLOSSY, SHADE- RAL 7035, SUPPLIER PART CODE- ULTRA SHIELD - XT, MAKE - NANOVA CARE COAT
c	Dry Film Thickness	micron	135-155
d	Adhesion Test		Peel-off test
10	**Noise level at 100% load condition**	dbA	85 at 1.5 m in free field (average)
	Vibration	mm/sec	Less than 2.8mm/sec at Chiller unit base plate.
11	**Major Component Make**		
a	Electronic Expansion Valve		Carel
b	Pr. Relief valve evaporator		Muller / Henry - 13 Bar
c	Pr. Relief valve condenser		Muller / Henry - 16 Bar
d	Temperature sensor		Carel NTC060WF00 (-50 to 105 deg C)
e	Pressure sensor		Carel SPKT0011C0 (0 to 44.8 Bar)
f	Control Panel		Kirloskar Chillers Pvt. Ltd.
12	**Accessories with Chiller**		
13	**For Condenser**		
a	Vent and drain connections		Provided
b	Relief valve		Provided
c	Refrigerant charging Valve		Provided
d	Isolating valves (Shut off valves will be provided at liquid line as well as discharge line)		Provided
e	Flow Switches		Provided
f	Temperature sensors at inlet & outlet		Provided
14	**For Evaporator**		
a	Vent and drain connections		Provided
b	Relief valve		Provided
C	Flow Switches		Provided
d	Temperature sensors at inlet & outlet		Provided
e	Antifreeze Thermostat		Antifreeze Safety is taken care by the controller, hence anti- freeze thermostat is not required.

REVIEWED
By VIPIN NAUNI at 3:12 pm, Jan 03, 2019

KIRLOSKAR CHILLERS PRIVATE LIMITED
A Kirloskar Group Company
S. NO. 613, PUNE-SASWAD ROAD, SASWAD, PUNE - 412 301, MH, INDIA
Enriching Lives

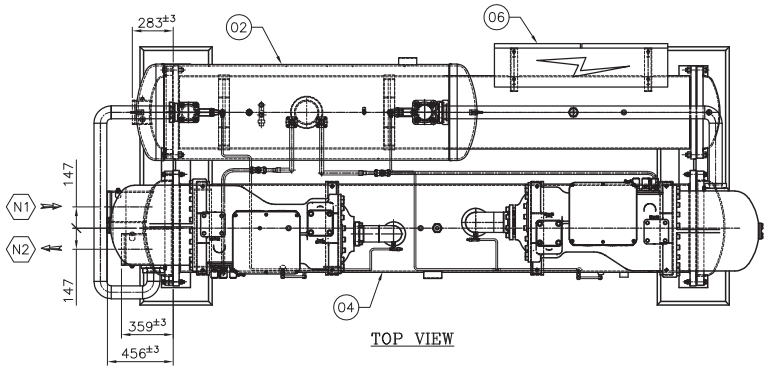
REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN NSB
CHD SAI
APPD SNM
DATE 02/08/18

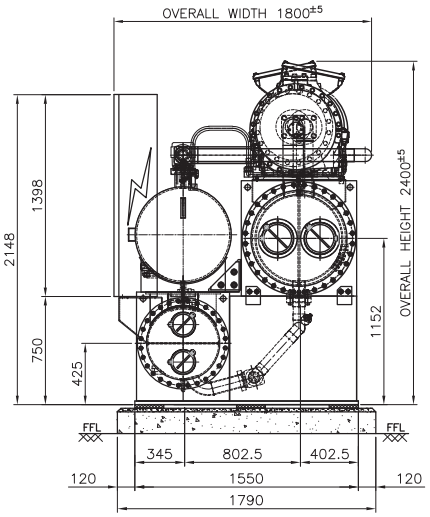
TITLE:
GENERAL ARRANGEMENT AND FOUNDATION DETAIL DRAWING FOR WATER COOLED SCREW CHILLER

MODEL: KWE330.24 | SCALE: 1:34 | SHEET: 1 OF 2 | DRG. NO.: 17.330.24.111.01.01 | REV. R00

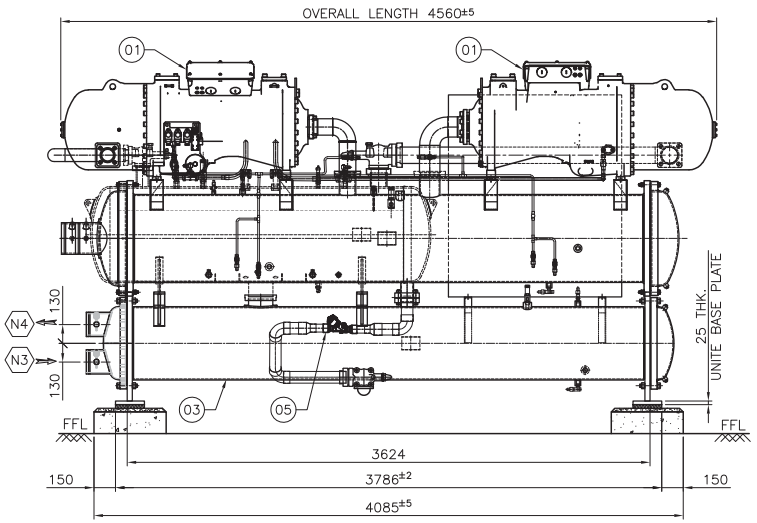
REVIEWED
By VIPIN NAUNI at 3:12 pm, Jan 03, 2019



TOP VIEW



L.H. SIDE VIEW



FRONT VIEW

LEGENDS

PART NO	DESCRIPTION	QTY.
1	SCREW COMPRESSOR	2
2	OIL SEPARATOR	1
3	CONDENSER	1
4	EVAPORATOR	1
5	ELECTRONIC EXPANSION VALVE	1
6	STARTER AND CONTROL PANEL	1

FFL : FINISHED FLOOR LEVEL

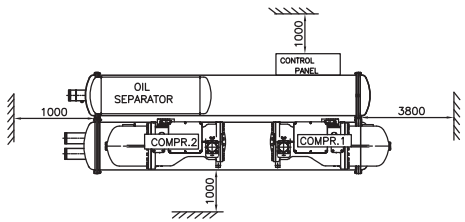
NOZZLE SCHEDULE FOR WATER CONNECTIONS

NOZZLE TAG	SIZE	QTY.	SCH/THK.	END CONNECTION (NOTE-7)	SERVICE
N1	200NB	1	SCH 40	GROOVE SUITABLE FOR VICTAULIC	CHILLED WATER IN
N2	200NB	1	SCH 40	GROOVE SUITABLE FOR VICTAULIC	CHILLED WATER OUT
N3	150NB	1	SCH 40	GROOVE SUITABLE FOR VICTAULIC	COOLING WATER IN
N4	150NB	1	SCH 40	GROOVE SUITABLE FOR VICTAULIC	COOLING WATER OUT

SYSTEM CHARGE AND WEIGHTS

MODEL	APPROX. CHARGE		APP. WATER VOLUME		APP. UNIT WEIGHT	
	R134a (kg)	LUBE OIL (kg)	EVAP. (Ltr)	COND. (Ltr)	SHIPPING (kg)	OPERATING (kg)
KWE330.24	244	60	220	180	6680	7080

RECOMMENDED SERVICE CLEARANCE



* 1500mm SERVICE CLEARANCE IS RECOMMENDED ON TOP.

NOTES:
1) LOW PRESSURE AND HIGH PRESSURE SIDE RELIEF VALVES (1"NPT CONNECTION) TO BE PIPED AS PER ANSI/ASHARE 15.
2) 3800mm IS REQUIRED AT ONE END OF TUBE SHEET FOR TUBE REPLACEMENT, 1000mm IS RECOMMENDED ON ALL OTHER SIDES AND 1500mm IS RECOMMENDED ON TOP FOR SERVICING. FAILURE TO HEED RECOMMENDED CLEARANCES MAY CAUSE SERVICING PROBLEMS.
3) IF MAIN POWER WIRING IS BROUGHT UP THROUGH THE FLOOR, THEN IT MUST BE OUTSIDE THE BOUNDARY OF UNIT.
4) UNIT SHALL BE SHIPPED WITH OPERATING CHARGE OF REFRIGERANT AND LUBRICATION OIL.
5) 4 NOS OF 38mm DIA. LIFTING HOLES ARE PROVIDED (REFER INSTALLATION MANUAL FOR LIFTING INSTRUCTIONS).
6) SERRATED RUBBER PADS ARE PROVIDED FOR VIBRATION ISOLATION AS A STANDARD BY KCPL (FOR FOUNDATION DETAIL REFER SHEET 2 OF 2).
7) WATER END CONNECTIONS SHALL BE GROOVED SUITABLE FOR VICTAULIC COUPLING. THE COUPLING AND EXTENDED GROOVE PIECE SHALL BE IN RCS SCOPE.

REFERENCE DRG NO:

P 6 36

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Enriching Lives

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DRAWING BY CAD–DO NOT MANUALLY MODIFY THIS DRAWING.

REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

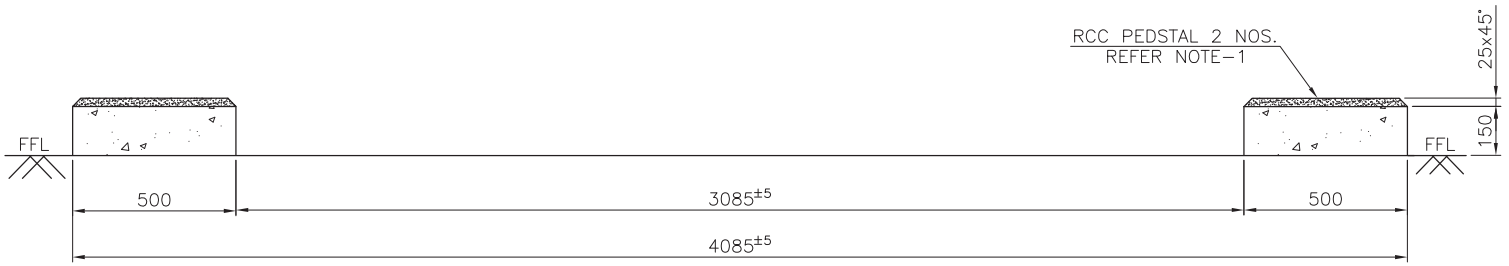
DRN NSB
CHD SAI
APPD SNM
DATE 02/08/18

TITLE:
GENERAL ARRANGEMENT AND FOUNDATION DETAIL DRAWING FOR WATER COOLED SCREW CHILLER

MODEL: KWE330.24
SCALE: 1:15
SHEET: 2 OF 2
DRG. NO.: 17.330.24.111.01.01
REV. R00

REVIEWED
By VIPIN NAUNI at 3:12 pm, Jan 03, 2019

PLAN



SECTION 'A–A'

NOTES:
1) DESIGN AND ERECTION OF FOUNDATION IS IN BHEL SCOPE. THE FOUNDATION SHALL BE DESIGNED FOR LOAD CARRYING CAPACITY WHICH IS 1.2 TIMES OF THE CHILLER OPERATING WEIGHT.
2) FOR CHILLER WEIGHT DETAILS, REFER SYSTEM CHARGE AND WEIGHTS TABLE FROM SHEET 1 OF 2.

P 7 36

REFERENCE DRG NO:

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REV.	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN MRM
CHD ASP
APPD SSN
DATE 01/11/18

TITLE:
WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PCO5 CONTROLLER

MODEL: KWE.2
SCALE: NTS
SHEET: 1 OF 6
DRG. NO.: 12.330.24.80W.10.C
REV. R00

415V AC +/- 10
50HZ +/- 3%
3PH, 4 WIRE
SUPPLY BY BHEL

R Y B N

TO HEATER PG2

HRC FUSE CKT1

HRC FUSE CKT2

MCB3 2AMP.

MCB4 2AMP.

M1 D1 S1

M2 D2 S2

1R2 1Y2 1B2 1R1 1Y1 1B1

L1 L2 L3

INT69 FRY MOTOR PROTECTOR

L N 1 2 11 14 12

1TB2-1 1TB2-2 1TB2-3 1TB2-4

2TB2-1 2TB2-2 2TB2-3 2TB2-4

129 129A CURRENT CONVERTER CARD (C.T.-1)

229 129A CURRENT CONVERTER CARD (C.T.-2)

U V W Y Z X

174 175 51 124

FROM WINDING PROTECTION SENSOR(COMP1)

TO CONTROLLER ID5

COMP-1 MOTOR

FROM WINDING PROTECTION SENSOR(COMP2)

TO CONTROLLER ID11

COMP-2 MOTOR

NOTE: FOR CHILLER MODEL KWE 240.24 & ABOVE 1no. EXV DRIVER BOARD TO BE USED (i.e.SINGLE LIQUID LINE) WHEREAS FOR KWE 395.24 & ABOVE 2nos EXV DRIVER BOARD TO BE USED (i.e.DOUBLE LIQUID LINE)

REFERENCE DRG NO: 12.330.24.80W.10 REV.06

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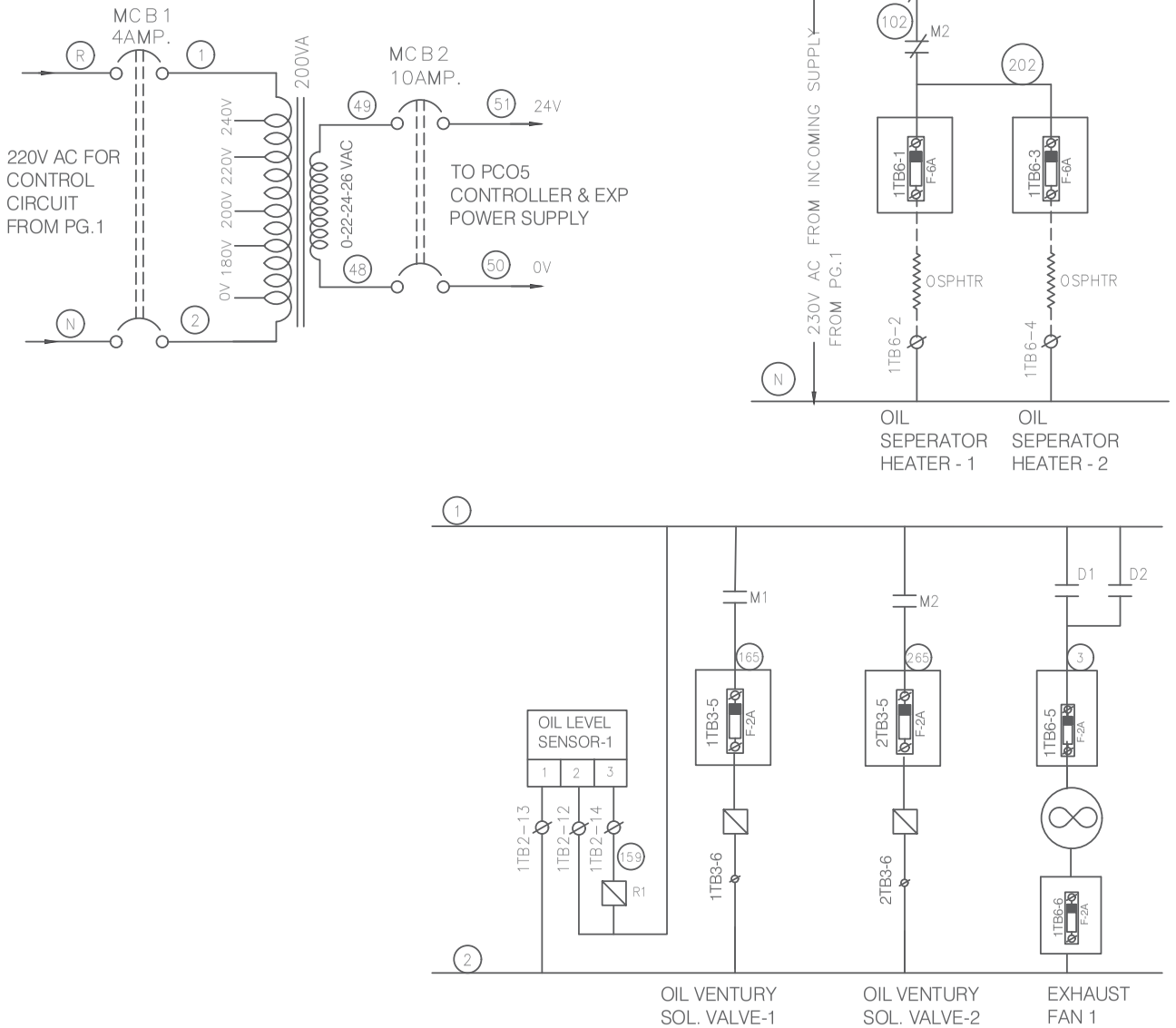
REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN: MRM | CHD: ASP | APPD: SSN | DATE: 01/11/18

TITLE: WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PCO5 CONTROLLER

MODEL: KWE.2 | SCALE: NTS | SHEET: 2 OF 6 | DRG. NO.: 12.330.24.80W.10.C | REV.: R00



REFERENCE DRG NO: 12.330.24.80W.10 REV.06

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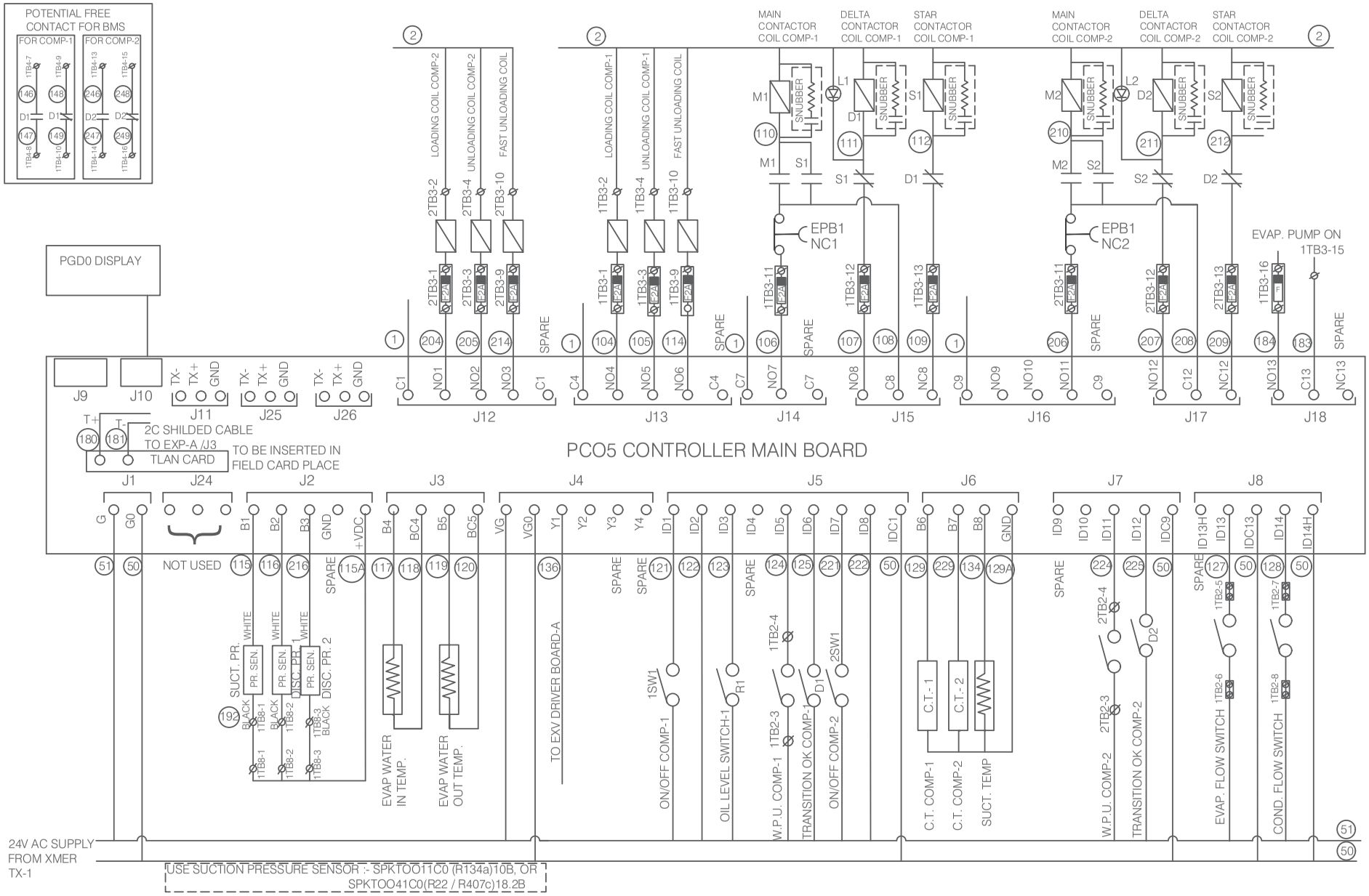
REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN: MRM | CHD: ASP | APPD: SSN | DATE: 01/11/18

TITLE: WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PCO5 CONTROLLER

MODEL: KWE.2 | SCALE: NTS | SHEET: 3 OF 6 | DRG. NO.: 12.330.24.80W.10.C | REV.: R00



REFERENCE DRG. NO: 12.330.24.80W.10 REV.06

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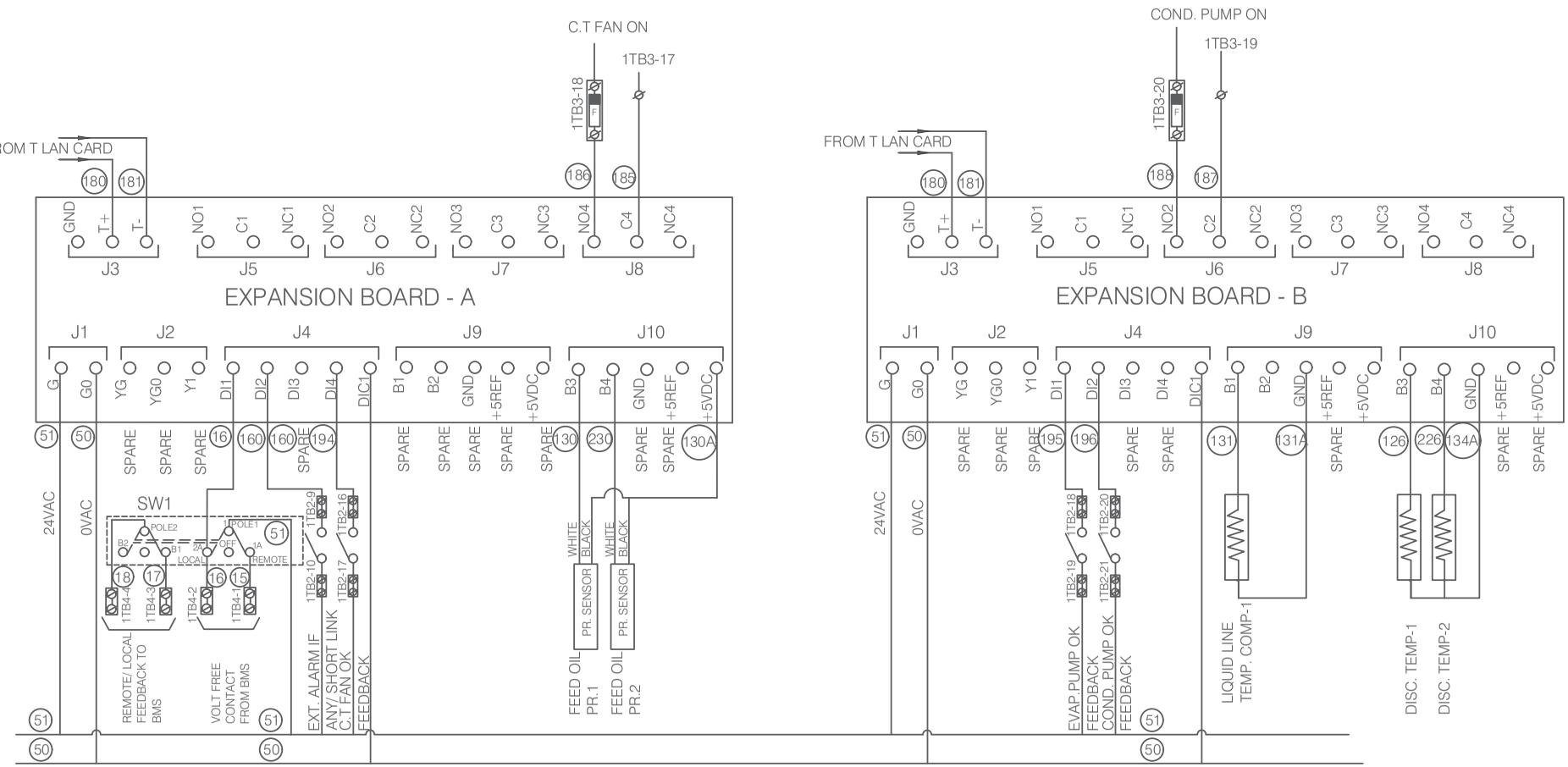
REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN: MRM
CHD: ASP
APPD: SSN
DATE: 01/11/18

TITLE: WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PC05 CONTROLLER

MODEL: KWE.2
SCALE: NTS
SHEET: 4 OF 6
DRG. NO.: 12.330.24.80W.10.C
REV. R00



NOTE: FOR CHILLER MODEL KWE 240.24 & ABOVE 1no. EXV DRIVER BOARD TO BE USED (i.e.SINGLE LIQUID LINE) WHEREAS FOR KWE 395.24 & ABOVE 2nos EXV DRIVER BOARD TO BE USED (i.e.DOUBLE LIQUID LINE)

REFERENCE DRG. NO: 12.330.24.80W.10 REV.06

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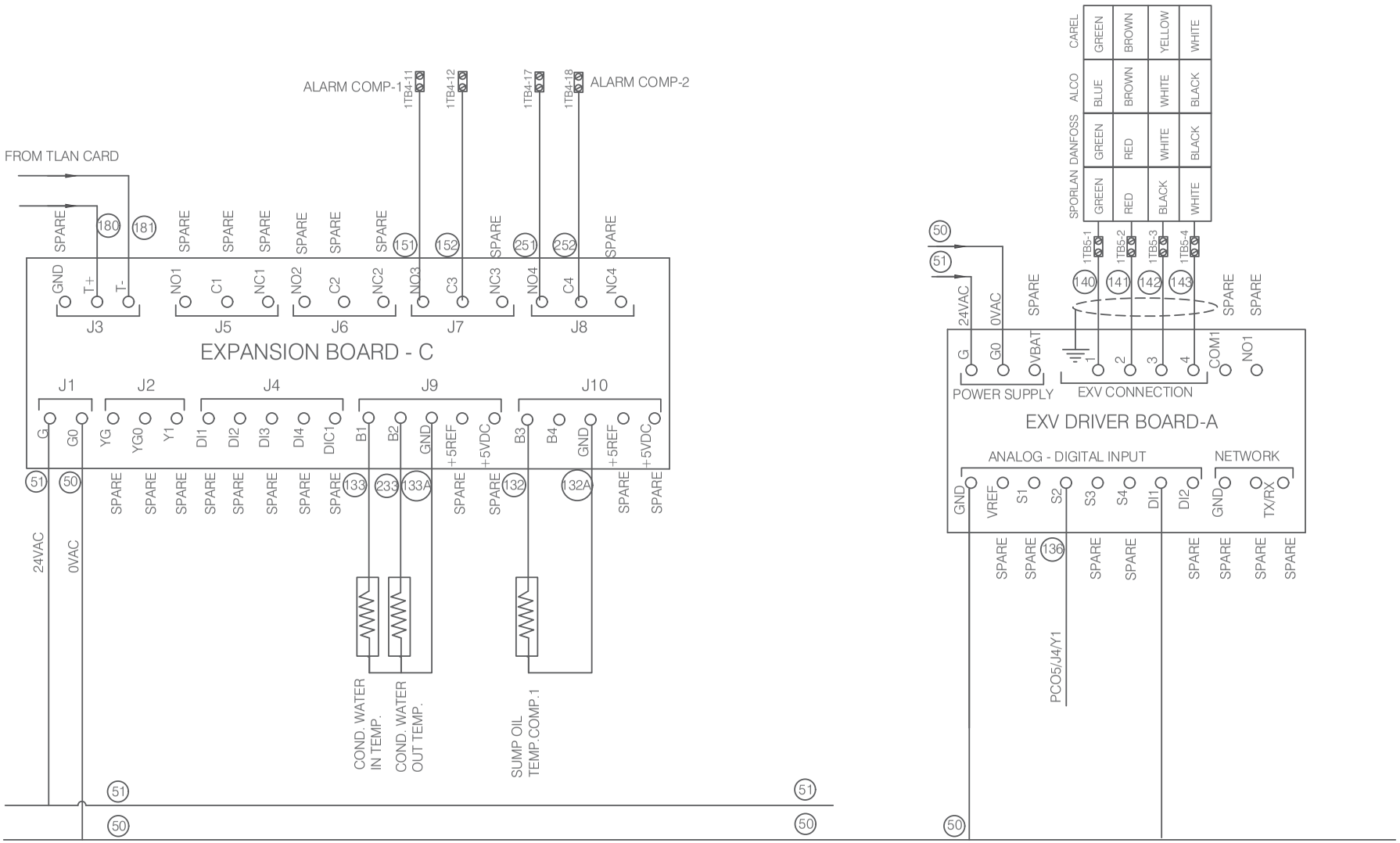
REV.	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN MRM | CHD ASP | APPD SSN | DATE 01/11/18

TITLE:

WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PCO5 CONTROLLER

MODEL: KWE.2 | SCALE: NTS | SHEET: 5 OF 6 | DRG. NO.: 12.330.24.80W.10.C | REV. R00



NOTE: FOR CHILLER MODEL KWE 240.24 & ABOVE 1no. EXV DRIVER BOARD TO BE USED (i.e.SINGLE LIQUID LINE) WHEREAS FOR KWE 395.24 & ABOVE 2nos EXV DRIVER BOARD TO BE USED (i.e.DOUBLE LIQUID LINE)

REFERENCE DRG NO: 12.330.24.80W.10 REV.06

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REV	DATE	REVISION DESCRIPTION	DRN	CHD	APPD

DRN: MRM | CHD: ASP | APPD: SSN | DATE: 01/11/18

TITLE: WIRING DIAGRAM FOR KWE, DUAL CIRCUIT WITH PC05 CONTROLLER

MODEL: KWE.2 | SCALE: NTS | SHEET: 6 OF 6 | DRG. NO.: 12.330.24.80W.10.C | REV. R00

1TB2

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
174	175	51	124	127	51	128	51	160	51		1	2	159		194	51	195	51	196	51	1	2	1R2	1Y2	1B2

WPU SENSOR OF COMP1 | TO PC05/ID5 | EVAP. FLOW INTERLOCK (BY BHEL) | COND. FLOW INTERLOCK (BY BHEL) | EXTERNAL ALARM IF ANY/ SHORT LINK | SPARE | OIL LEVEL SWITCH-1 | SPARE | C.T FAN OK FEEDBACK | EVAP PUMP OK EEDBACK | COND.PUMP OK EEDBACK | 230V AC TO KRIWAN UNIT | 3 PHASE SUPPLY TO KRIWAN UNIT

EARTHING STRIP (BY BHEL)

1TB5

1	2	3	4
140	141	142	143

TO ELECTRONIC EXP. VALVE-1

1TB8

1	2	3	4	5	6	7	8	9
115A	15A	15A	1A	2A	3A	192	116A	216A

1	2	3	4	5	6	7	8	9
1B	2B	3B	115	116	216			

ALL PRESSURE SENSOR GROUND J2

1TB4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
15	16	17	18			146	147	148	149	151	152	246	247	248	249	251	252

D1 | D1 | EXP-C/ J6/RO-3 | D2 | D2 | EXP-C/ J7/RO-4

VOLT FREE CONTACT FROM BMS | LOCAL / REMOTE FEEDBACK TO BMS | SPARE | COMP-1 ON | COMP-1 OFF | ALARM COMP-1 | COMP-2 ON | COMP-2 OFF | ALARM COMP-2

1TB3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
104	2	105	2	165	2			114	2	106	107	109	183	184		185	186	187	188

FROM PCO5/ J14/NO7 | FROM PCO5/ J15/NO8 | FROM PCO5/ J15/NC8 | FROM PCO5/ J18/C4 | FROM PCO5/ J18/NO13 | FROM EXP.A/ J8/C4 | FROM EXP.A/ J8/NO4 | FROM EXP.B/ J6/C2 | FROM EXP.B/ J6/NO2

LOADING SOL. VALVE COMP-1 | UNLOADING SOL. VALVE COMP-1 | OIL VENTURY SOL. VALVE COMP-1 | SPARE | V3 COIL COMP-1 | SPARE | EVAP. PUMP ON/OFF COMMAND | C.T FAN ON/OFF COMMAND | COND. PUMP ON/OFF COMMAND

1TB6

1	2	3	4	5	6	7	8
102	N	202	N	3	2		

OIL SEPERATOR HEATER-1 | OIL SEPERATOR HEATER-2 | EXHAUST FAN 1 | SPARE

2TB2

1	2	3	4	5	6	7	8	9
176	177	51	124	1	2	2R2	2Y2	2B2

WPU SENSOR OF COMP 2 | TO PC05/ID11 | 230V AC TO KRIWAN UNIT | 3 PHASE SUPPLY TO KRIWAN UNIT

2TB3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
204	2	205	2	265	2			214	2	206	207	209							

FROM PCO5/ J16/NO11 | FROM PCO5/ J17/NO12 | FROM PCO5/ J17/NC12

LOADING SOL. VALVE COMP-2 | UNLOADING SOL. VALVE COMP-2 | OIL VENTURY SOL. VALVE COMP-2 | SPARE | V3 COIL COMP-2 | SPARE | SPARE

REFERENCE DRG NO: 12.330.24.80W.10 REV.06

I). Following data shall be available on display of the controller

1) Suction Pressure
2) Discharge Pressure
3) Chilled Water Inlet Temp
4) Chilled Water Outlet Temp
5) Condenser Water Inlet Temp
6) Condenser Water Outlet Temp
7) Liquid Line Refrigerant Temp
8) Suction Line Refrigerant Temp.
9) Saturated Suction Temp.
10) Suction Super Heat
11) Saturated Discharge Temp.
12) Discharge line Refrigerant Temp.
13) Discharge Super Heat
14) Evaporator Approach
15) Condenser Approach
16) Compressor Motor Current in Amp (only one phase) 17) Compressor Motor Current in % RLA
18) Date & Time
19) Compressor On / Off
20) Water flow ON/OFF indication (Condenser)
21) Water flow ON/OFF indication (Evaporator)
22) Oil temperature (for KW4, KWK & KA4 chiller models only)
23) Oil feed pressure (for KW4, KWK & KA4 chiller models only)
24) Differential Oil pressure
25) Motor winding temperature – Healthy or Un-healthy 26) Voltage Protection Device – Healthy or Un-healthy 27) EXV opening %

II) Safeties: - Following safeties are directly sensed by the controller & acted upon

(A) Pressure Alarms

1. High Discharge Pressure
2. Low Suction Pressure

3. Low Oil Pressure Differential
4. Unsafe Oil Pressure
5. Dirty Filter Pressure

(B) Temperature Alarms

1. High Discharge Temperature
2. High Oil Temperature
3. Antifreeze Trip.

(C) Current Alarms

1. High current
2. Low current

(D) Pro Active unload for

1. High Current
2. High Discharge Pressure
3. Low Suction Pressure

III) Other safeties which are sensed by other devices, but action is taken by the controller :

1. Over voltage / Under voltage/ Single phasing / Reverse phasing / Voltage unbalance.
2. Motor Winding Overheat.
3. Low Condenser Water Flow.
4. Low Chilled Water Flow.

Certificate of Product Ratings

AHRI Certified Reference Number : 8929181 Date : 08-29-2018 Model Status : Active

Brand Name : KIRLOSKAR CHILLERS PRIVATE LIMITED

Model Designation : KWE330.24

Rated as follows in accordance with the latest editions of ANSI/AHRI Standards 550/590 (I-P) with Addendum 3 and 551/591 (SI) with Addendum 3 for Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Refrigerant Used per ASHRAE 34 : R-134a

Compressor Model Series Information : KXH9

Compressor Type : Screw

Primary Catalog or Selection Rating Application Name : KCPL Chiller Selection System

Primary Catalog or Selection Rating Application Version : Version-1.4.4

Hert : 50

Country of Origin : India

Application : Cooling

Certified to EN 14511 and EN14825 : NO

"Active" Model Status are those that an AHRI Certification Program Participant is currently producing AND selling or offering for sale; OR new models that are being marketed but are not yet being produced. Production Stopped Model Status are those that an AHRI Certification Program Participant is no longer producing BUT is still selling or offering for sale.

Ratings that are accompanied by WAS indicate an involuntary re-rate. The new published rating is shown along with the previous (i.e. WAS) rating.

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CERTIFICATE NO.: 131799978905111913





Cooling Synergies

Kirloskar

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P 18 36

Leadership, Innovation, Advanced Technology Synergize Here!

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130 Years of Engineering Innovation

Kirloskar Chillers is proud to be a part of the 130-year-old **Kirloskar Group**, a diversified engineering conglomerate that gave India its first iron plough, water pump, electric motor, compressor & engine. In the present era, we spearhead the effort to introduce energy efficient & eco-friendly 'GREEN' products to the Indian market. Today, the Group not only has a strong presence in India, but also in more than 70 countries across the globe.

KIRLOSKAR CHILLERS PRIVATE LIMITED

Kirloskar Chillers, a future-focused organization, is committed to introducing innovative products for comfort & process cooling and heating applications. The company commenced its operations in 1996 & since then has been demonstrating its commitment to achieving customer delight in every aspect of its business.

The 1st Company in India to manufacture both Centrifugal & Screw chillers, designed for a wide range of operating conditions, we lead the industry in energy efficiency, complying with or exceeding prevailing environment norms. We take pride in being the first company in India to establish an AHRI-certified chiller test bed at our manufacturing facility at Pune, India, evidence of our commitment to offer products meeting global standards.

Our ability to offer our customers superlative product quality, flexibility in meeting expectations, and prompt & competent service support are our USPs, enabling us to achieve the status of 'preferred chiller supplier' for our customers, not just in India but across the globe.

Indian Green Building Council
FOUNDING MEMBER

P 21 36

PRODIGY® Water Cooled Screw Chillers

KWE Series: Flooded Evaporator Screw Chillers

Features & Benefits

Kirloskar PRODIGY® KWE series water cooled flooded screw compressor chillers are equipped with one or two compressors. These chillers use flooded evaporators enabling to achieve efficiency as high as 0.62 kW/tonR (COP 5.7) at standard AHRI rating conditions.

Each PRODIGY® KWE series water cooled screw chiller is equipped with:

- 1 or 2 twin-screw compressors, equipped with semi hermetic, refrigerant cooled, squirrel cage two pole induction motor suitable for voltages between 380 ~ 460V. These high efficiency compressors are designed for quiet operation & have step-less capacity control from 25 ~ 100% load for Single Compressor and 12.5 ~ 100% load for Dual Compressor chillers.
- Well-designed external oil separator, efficient & reliable oil recovery system to recover traces of oil carried over into the heat exchangers.
- Shell & tube condenser with enhanced surface copper tubes & removable water heads.
- Flooded shell & tube evaporator with enhanced surface copper tubes & removable water heads.
- Electrical panel housing intelligent 'K-Smart' controller with LCD display
- Anti-vibration rubber pads for field installation.

Options & Accessories

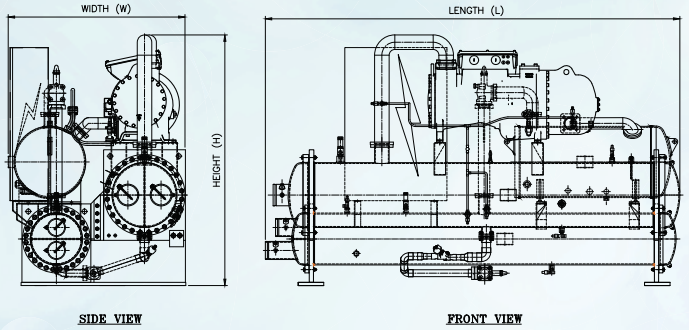
The following options are available for all PRODIGY® KWK series water cooled screw chillers:

- Water flow switches.
- Spring isolators for vibration isolation.
- Witness testing on AHRI certified test bed, at design conditions, at full and part loads.

PRODIGY SERIES

Approximate Range:
100 TR (350 kW) up to 450 TR (1580 kW)

Physical Dimensions :



PRODIGY® Water Cooled Screw Chillers - KWE Series (HFC 134a)

Parameter / Model	UOM	KWE 100.14	KWE 115.14	KWE 135.14	KWE 155.14	KWE 175.14	KWE 190.14	KWE 210.14	KWE 225.14	KWE 200.24	KWE 230.24	KWE 250.24
Nominal Cooling Capacity	TR	101	115	130	155	175	191	211	225	204	230	250
Compressor Type		Semi Hermetic Twin Screw										
No. of Compressors	#	1	1	1	1	1	1	1	1	2	2	2
Capacity Control	%	Stepless 100-25%								Stepless 100-12.5%		
Approx. Ref Charge	kg	110	120	140	160	160	180	180	195	180	195	220
Evaporator Type		Shell And Tube - Flooded Type										
Evaporator Water Volume	Ltr	85	90	105	125	135	175	125	150	115	140	155
Evaporator Water Nozzle Size	NB	150	150	150	200	200	200	150	200	150	200	200
Condenser Type		Shell And Tube - Flooded Type										
Condenser Water Volume	Ltr	75	80	95	105	115	135	115	130	105	130	145
Water Nozzle Size	NB	125	125	125	125	125	150	125	125	125	125	125
Length	mm	3450	3450	3450	3550	3550	3590	4340	4450	4340	4450	4680
Width	mm	1420	1420	1420	1460	1490	1650	1480	1500	1380	1400	1400
Height	mm	2120	2120	2140	2200	2250	2270	2200	2250	2120	2080	2250
Shipping Weight	kg	3260	3270	3960	4120	4190	4490	4600	4790	4610	4970	5580
Operating Weight	kg	3420	3440	4160	4350	4440	4800	4845	5070	4845	5240	5880

Parameter / Model	UOM	KWE 270.24	KWE 290.24	KWE 310.24	KWE 330.24	KWE 350.24	KWE 365.24	KWE 380.24	KWE 405.24	KWE 420.24	KWE 435.24	KWE 450.24
Nominal Cooling Capacity	TR	270	290	310	330	349	365	381	404	422	436	449
Compressor Type		Semi Hermetic Twin Screw										
No. of Compressors	#	2	2	2	2	2	2	2	2	2	2	2
Capacity Control	%	Stepless 100-12.5%										
Approx. Ref Charge	kg	220	240	240	244	275	290	300	325	344	423	440
Evaporator Type		Shell And Tube - Flooded Type										
Evaporator Water Volume	Ltr	165	200	210	220	225	245	250	260	290	340	370
Evaporator Water Nozzle Size	NB	200	200	200	200	200	200	200	200	200	250	250
Condenser Type		Shell And Tube - Flooded Type										
Condenser Water Volume	Ltr	155	170	170	180	205	225	230	250	260	310	340
Condenser Water Nozzle Size	NB	125	150	150	150	150	200	200	200	200	200	200
Length	mm	4760	4760	4760	4760	4760	4780	4780	4780	4780	4850	4850
Width	mm	1420	1640	1640	1640	1640	1620	1620	1620	1620	1820	1820
Height	mm	2280	2380	2380	2400	2400	2400	2400	2400	2400	2470	2470
Shipping Weight	kg	6240	6540	6560	6680	6810	6960	7010	7410	7800	8530	8680
Operating Weight	kg	6560	6910	6940	7080	7240	7430	7490	7920	8350	9180	9390

Notes:
1. Cooling capacity: For condenser water inlet/outlet temperatures 30º / 34ºC and evaporator water outlet/inlet temperatures 7º / 12ºC respectively.
2. Input power supply: 415 V / 50 Hz / 3-Phase.
3. Fouling factors according to AHRI 550 / 590 & 551 / 591.
4. All weight and dimensions are approximate.

To select optimised chiller configuration & for options other than listed above, please contact your local Kirloskar Chillers sales office.

We nurture Trust & Responsibility in all relationships. Through every action, we demonstrate our intent to be an organisation responsible towards Society & Nature. We drive various initiatives to extend a helping hand to society & help protect the environment.

Enriching Lives

KIRLOSKAR CHILLERS PRIVATE LIMITED
A Kirloskar Group Company

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CIN: U29191PN1995PTC095733

P 24 36

Feb. 2018 - 1000 No. - Prithvi

CONTROL PHILOSOPHY

FOR

PRODIGY CHILLERS

TABLE OF CONTENTS

1. Introduction

The controller of typical chiller plant does various functions from precisely controlling chilled water temperature by loading/unloading compressor and managing EXV to logging data and alarm history. Off course while doing so it has to ensure safety by monitoring and proactively controlling some parameters. KCPL K smart controller can even manage allied plant equipment like CT fan, Pumps and valves. Satisfying all these requirements made feasible by today's fast microprocessor based controllers wherein many parallel control algorithms execute at the same time. Thus it's not straight forward affair to completely explain control philosophy of a chiller controller. It can be simplified by breaking chiller operations into its various states as well as looking at various parallel control loops one at a time.

2. List of Major Components in Chiller

Sr. No	Major Components
1	Screw Compressor
2	Evaporator
3	Condenser coils
4	Electronic Expansion Valve
5	Oil Cooler & Economizer (Optional)

3. Control Philosophy

The PRODIGY screw chiller operation can be divided as below sub-parts:

- ✓ Start up and Shut down sequence.
- ✓ Loading/Unloading of compressor to match external load.
- ✓ Proactive controlling and safety trips.
- ✓ Oil cooler operation.(Optional)
- ✓ Data and alarm history logging.
- ✓ Refrigerant flow control by electronic expansion valve.

Most of above operations happens simultaneously, with controller simultaneously executing all control loops. These are discussed here in detail one by one.

4.1. Start-up and Shut down: Working & Control Philosophy:-

The compressor is driven by semi-hermetic induction motor, which can be offered with various starter options such as Star-delta, Soft Starter, VFD etc. These starter panels and control panel is mounted on chiller. For details refer Control wiring diagram of control panel, starter panel and Interfacing wiring diagram.

Chiller can be operated in local mode & remote mode local/remote mode selection shall be done from chiller controller. Remote mode operation shall be initiated from BMS/Plant-Manager (PM) by start/stop command to chiller control panel. During manual mode BMS/Plant-Manager (PM) intervention shall be bypassed.

Refer algorithm for startup and shut down for detailed sequence.

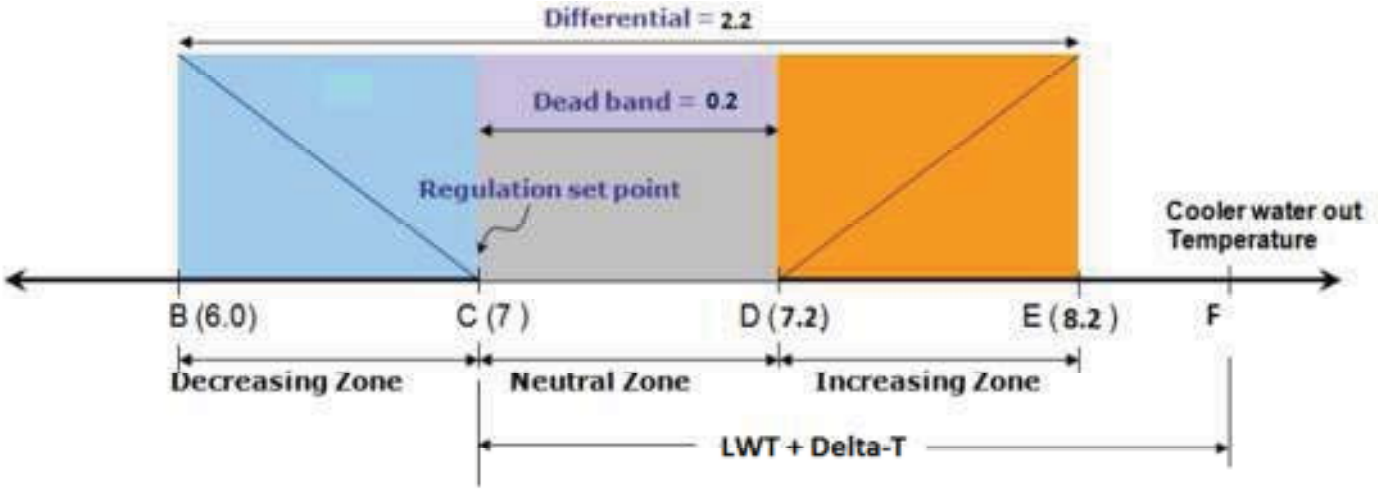


Fig 1. Shows the Increasing zone/Neutral zone/Decreasing zone calculated according to set points.

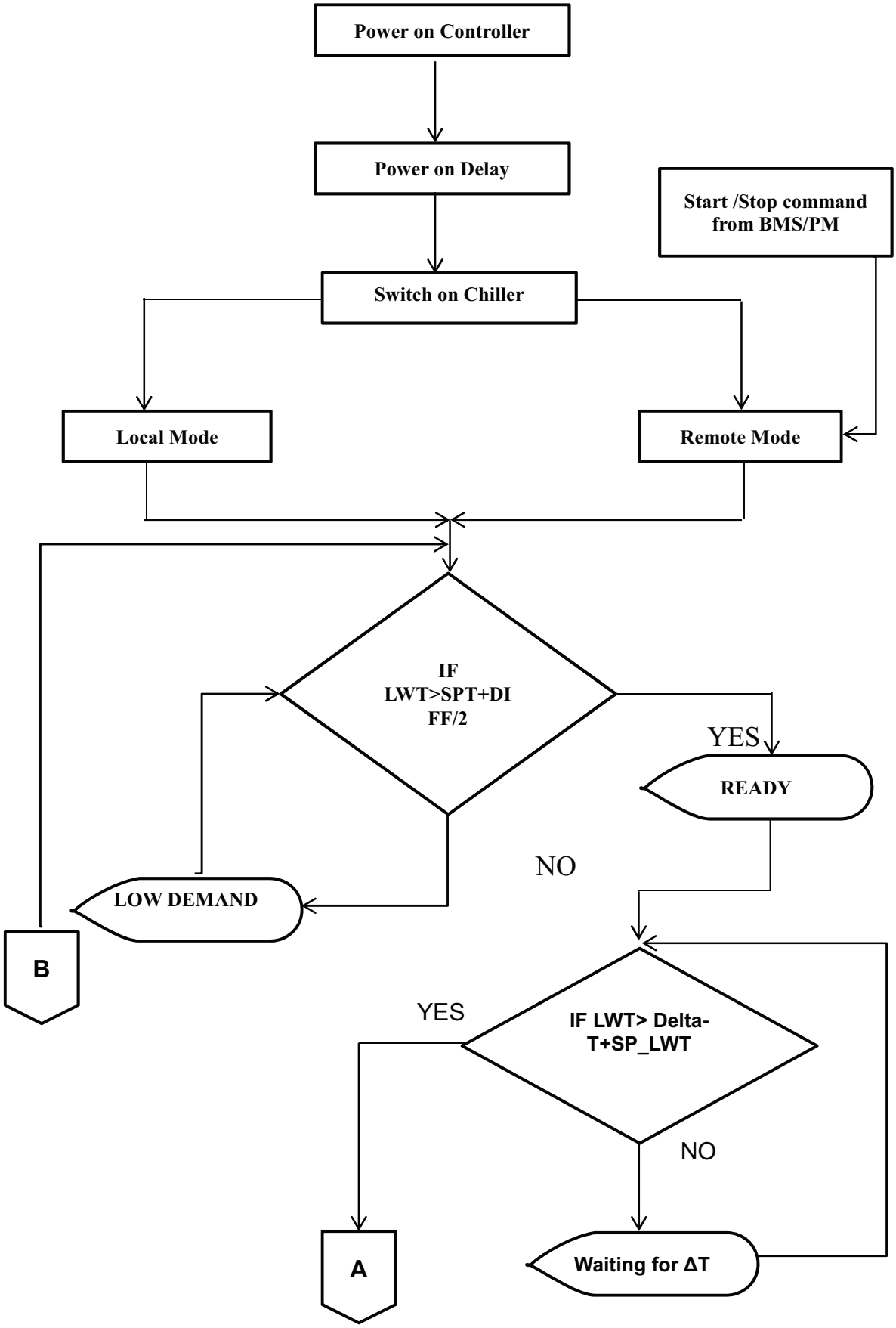


Fig 3 Algorithm for Startup and Shut down for Detailed Sequence (1)

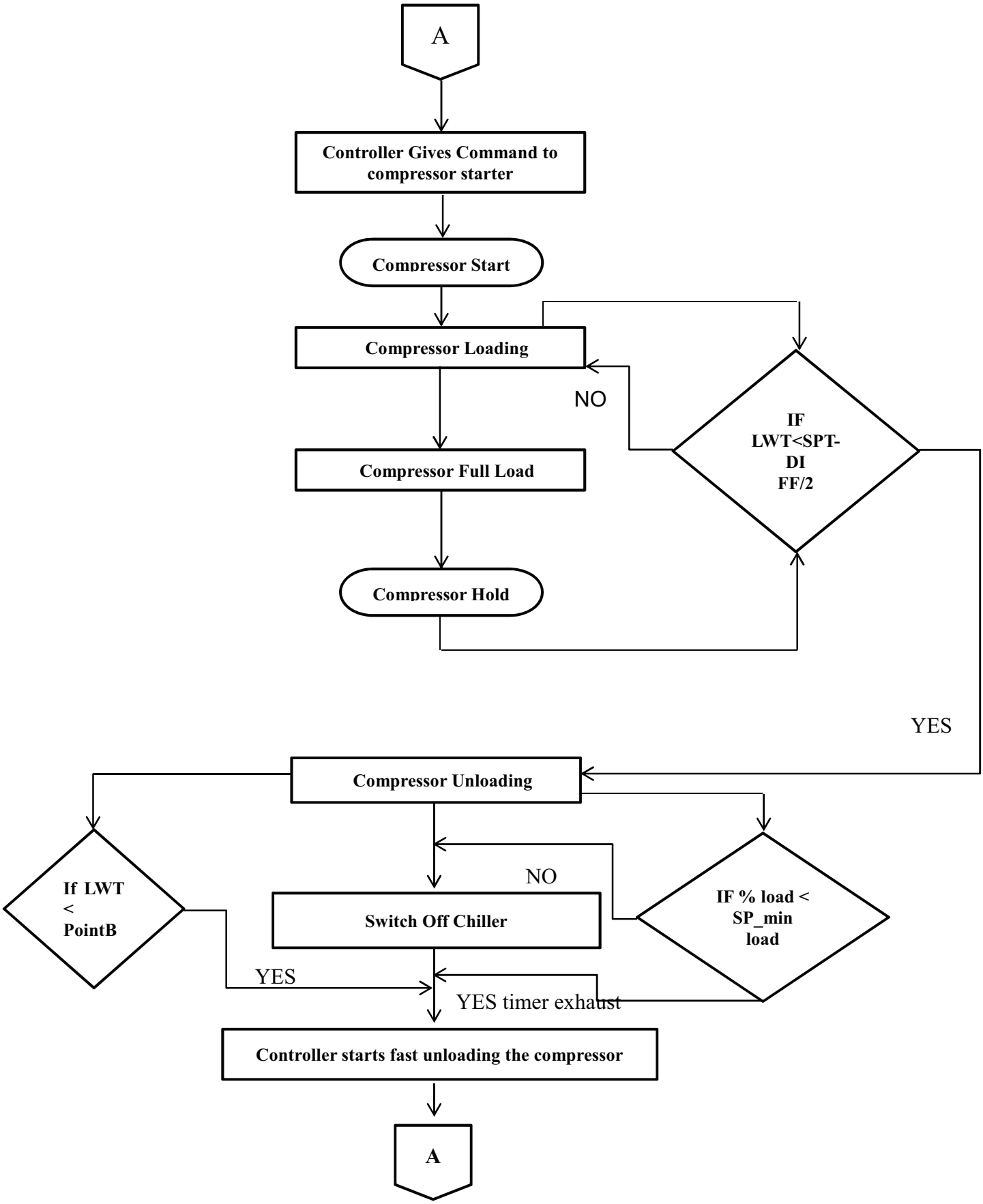

A
Controller Gives Command to compressor starter
Compressor Start
Compressor Loading
NO
IF LWT<SPT-DI FF/2
Compressor Full Load
Compressor Hold
YES
Compressor Unloading
If LWT < PointB
NO
Switch Off Chiller
IF % load < SP_min load
YES
YES timer exhaust
Controller starts fast unloading the compressor
A

Fig 4 Algorithm for Startup and Shut down for Detailed Sequence (2)

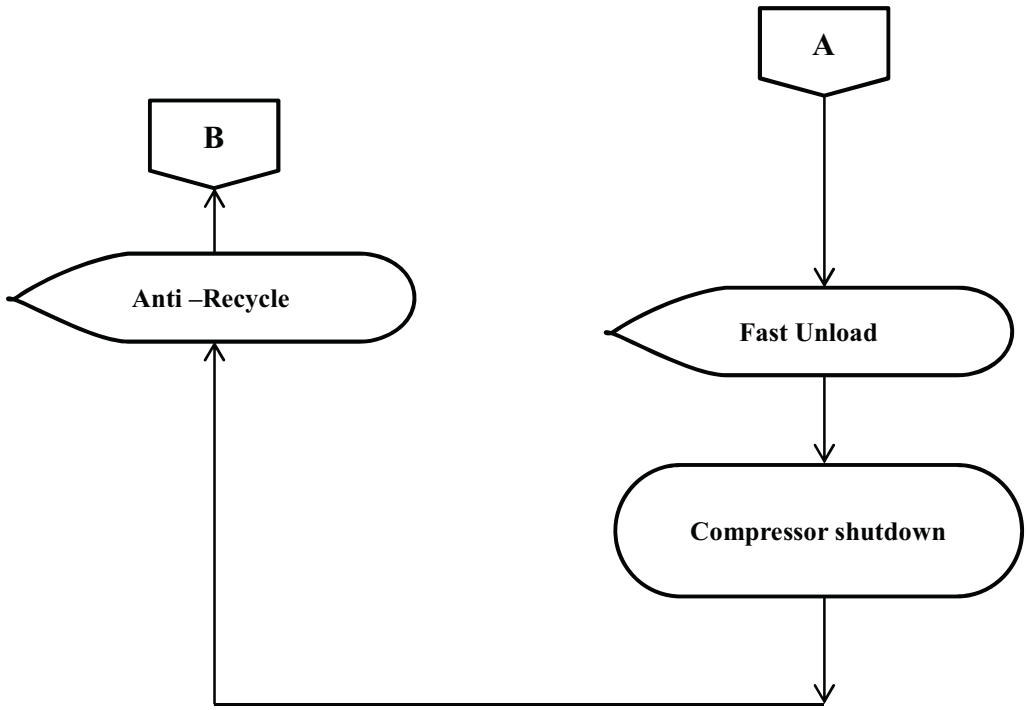


Fig 5 Algorithm for Startup and Shut down for Detailed Sequence (3)

4.2. Loading/Unloading Control: Working & Control Philosophy:-

Cooling capacity control is achieved by means of a slide valve mechanism controlled by microprocessor system through two solenoid coils and by varying speed by VFD. Each unit has infinitely variable (step less) capacity control from 100% down to 35%. This modulation allows the compressor capacity to match the building-cooling load. The result is a decrease in chiller energy costs, particularly at the part-load conditions at which the chiller operates most of the time.

Chillers are equipped with Electronic expansion valve, which quickly reacts to load variations and ensures precise, metered refrigerant flow into the evaporator.

Following diagram illustrates different zones viz; Increasing zone, Decreasing Zone and Dead band created by three set points – Target set pt., dead band & differential.

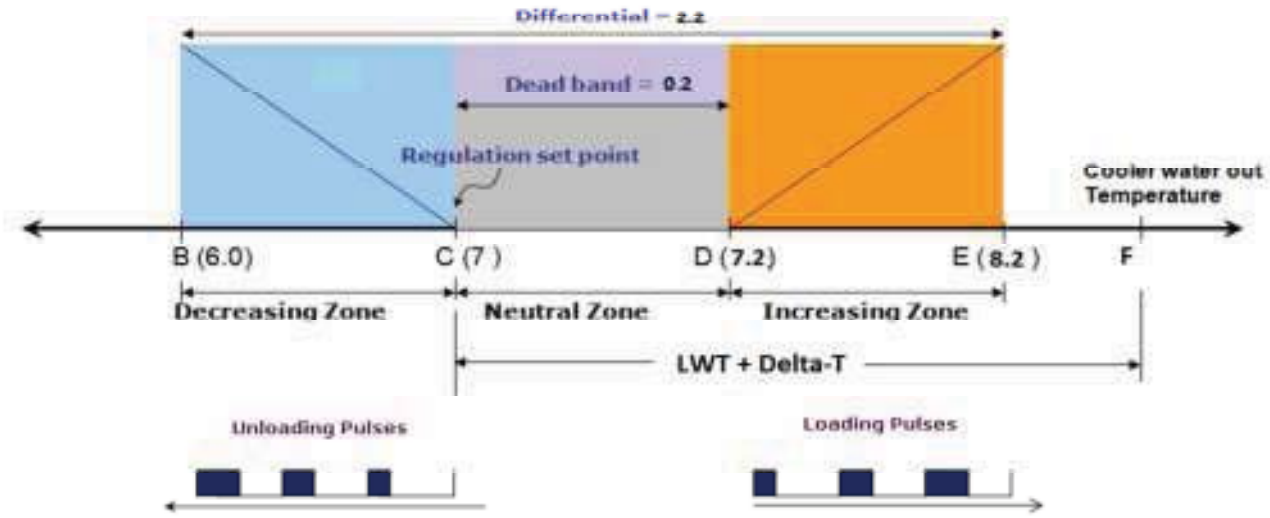


Fig.6 Loading Unloading PID Logic

The above diagram is self-explanatory, if the chilled water temperature is in increasing controller gives the loading pulses proportional to its deviation from neutral zone. If it's above the differential band (above pt. E) then it gives maximum size pulses. Similarly if the chilled water temperature is in decreasing zone controller gives the unloading pulses proportional to its deviation from neutral zone. If chilled water temperature drops below differential band (below pt. B), controller shuts the compressor off known as "Routine Shutdown" and restarts only when temperature rises above point F (LWT SP+ Delta-T Set point).

4.3. Proactive Controlling and Safety Trips:-

Various digital interlocks or safeties are provided for chiller, some of them are Auto reset, Means if the unsafe condition corrected automatically trip on controller vanishes while some of them are Manual reset, means operator has to reset the alarm then only chiller can be started. Following is list of digital safeties provided.

Sr. No	Interlock	Reset	Delay	Active During
1	DI CHILLER WATER FLOW	Auto	5 SEC	After the switch ON
2	DI VOLTAGE PROTECTION DEVICE	Manual	1 SEC	Throughout running of chiller
4	DI TRANSITION OK	Manual	10 SEC	Chiller starting
5	DI STARTER FAULT	Manual	1 SEC	Throughout running of chiller
6	DI COMPRESSOR WINDING	Manual	1 SEC	Throughout running of chiller

Apart from above digital safeties, various analog safeties are also provided. For some analog safeties instead of directly tripping compressor, K- smart controller utilizes the pro-active controlling. That means if any of the parameters goes to unsafe condition (Yellow zone) from healthy state (Blue zone); it first unloads the compressor and tries to correct the situation. If parameter returns again to healthy zone, it again loads it normally. If at all parameter goes to critical or risky zone (Red zone) it immediately stops the compressor.

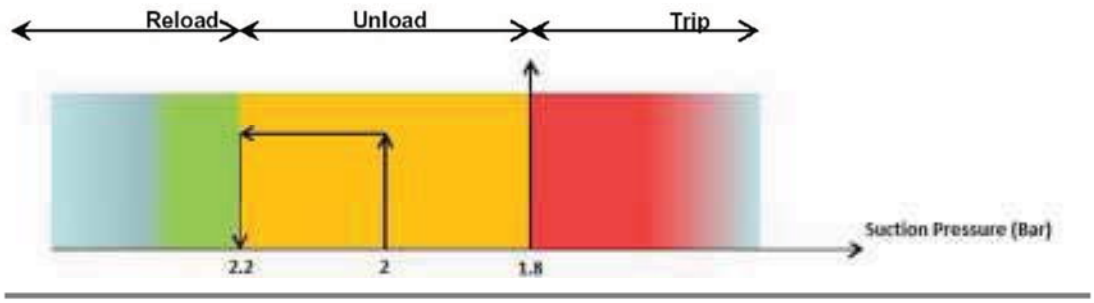


Fig.7 Proactive Controlling

4.3.1. List of Analog Safeties:-

Sr. No	Safety	Description	Proactive Controlling Applicable	Delay	Active when
1	PROBE ALARM	GENERATES WHEN PROBE BECOMES FAULTY	NO	10 SEC	After the power up delay
2	CURRENT ALARM-				
	a).LOW CURRENT TRIP	GENERATES WHEN CURRENT VALUE IS BELOW SET LIMITS	NO	2 SEC	During Compressor Running
	b).HIGH CURRENT TRIP	GENERATES WHEN CURRENT VALUE IS ABOVE SET LIMITS	YES	0 SEC	During Compressor Running
3	PRESSURE ALARM				
	a). VERY LOW SUCTION PRESSURE	GENERATES WHEN SUCTION PRESSURE IS BELOW MIN SET LIMIT	YES	2 SEC	During Compressor Running
	b). LOW SUCTION PRESSURE	GENERATES WHEN SUCTION PRESSURE IS BELOW LOW SET LIMIT	YES	15 SEC	During Compressor Running
	c). LOW OIL DIFF PRESSURE	GENERATES WHEN OIL PRESS IS BELOW SET LIMIT	NO	30 SEC	During Compressor Running
	d). HIGH DISCHARGE PRESSURE	GENERATES WHEN DISCH PRESS IS ABOVE SET LIMIT	YES	0 SEC	During Compressor Running
4	TEMPERATURE ALARM				
	a). ANTIFREEZE ALARM	GENERATES WHEN LWT IS BELOW ANTIFREEZE SET LIMIT	NO	0 SEC	During Compressor Running
	b). HIGH SUCTION TEMPERATURE	GENERATES WHEN SUCTION TEMP IS ABOVE SET LIMIT	NO	300 SEC	During Compressor Running
5	COMMUNICATION ALARM				
	a). EXP BOARD OFFLINE	GENERATES WHEN EXP BOARD NOT COMUNICATING WITH CONTROLLER	NO	25 SEC	After the power up delay
6	DP SWITCH				
	ACROSS EVAPORATOR	GENERATES WHEN BELOW LOW SET LIMIT	YES		

5.3.2. List of Minor and Major Alarms:-

MINOR	MAJOR
Probe Alarm	Low Current Trip
High Discharge Temperature	High Current Trip
Expansion Board Offline	Pressure Alarm –Very Low Suction Press
	Low Oil Differential Pressure
	High Discharge Pressure
	Anti-Freeze Alarm
	High Suction Temperature
	No Oil Flow

4.4. Oil Cooler & Economizer Operation (Optional):-

To control the oil temperature within certain band separate oil cooler PHE in oil sump & compressor body are provided. Oil Cooler On/Off is governed by following conditions.

- ✓ Oil Cooler On:

Oil temperature < *Oil cooler SP* + *ON Differential*

- ✓ Oil Cooler Off:

Oil temperature > Oil Cooler SP.

Similarly for Economizer, there is target load set point and ON/OFF differential which controls the opening closing of expansion valve and in turn control the water flow through PHE.

4.5. Data and Alarm History Logging:-

Apart from above parallel control loops, controller saves the 99 alarms and important Parameters at the time of each alarm. These alarms can be viewed on the controller screen one by one.

4.6. Refrigerant Flow Control by Electronic Expansion Valve:-

Electronic expansion valve is used to control the refrigerant flow with in desired limits. At startup EXV is operated on suction pressure to maintain suction pressure at desired value. After the startup sequence proactive control of EXV is done on suction pressure and suction superheat.

- ✓ EXV Open:

Suction Superheat > Superheat set point + Dead Zone +ve band.

- ✓ EXV Close:

Suction Superheat < Superheat set point - Dead Zone -ve band.

EXV is not operated in Dead-zone region. While maintaining Suction superheat controller also looks for suction pressure to be maintained at set value.

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. CE/E/P.I/SE/E/Prog. I/AEE/ E/P/F.Ennore SEZ Drg Appl./D.400 /19 DT.21.09.2019

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2019.02.06 18:04:20 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
12/12/2018	00	First Submission	Alam	Salim	SKT
27/11/2018	B	First Submission	Alam	Salim	SKT
28/07/2018	A	First Submission	Alam	Salim	PC

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

PACKAGE	**AIR CONDITIONING SYSTEM**
TITLE	**TDS of water cooled Condensing unit**

Water Cooled Cond. Operating Conditions			
		IN	OUT
100% load EWT	°C	32.0	36.0
Flow rate (gpm)	Usgpm	110.4	
Field fouling allowance	m2.°C/W	0.000044	
MODEL:ACWCUS028DMN2X1 PERFORMANCE (R22)			
Performance Tolerance as per ARI is applicable			
TR	**INPUT KW**	**% LOAD**	**IKW/TR**
27.2	21.2	100.0%	0.780
13.6	10.9	50.0%	0.801
Running Current in Amps @ 415 Volts **			**41.8**
Max.Running Current in Amps @ 415 Volts			**70.0**
Max.Starting Current in Amps @ 415 Volts			**195.9**
** at above operating conditions			
COP = 4.5			

Technical data	
UNIT MODEL	**ACWCUS028DMN2X1**
Nominal capacity -TR	28
COMPRESSOR	
Compressor make	Danfoss
Compressor model	SM185
Compressor qty.	2
RPM	2900
unit capacity reduction steps in %	100/50
oil type	Mineral/160P
oil charge/comp.lit	6.6
Unit starting current –amps at 400 volts	195.9
Max. Allowable operating current –amps per compressor at 400Volts	35
Refrigerant	R22
Noise level	82+/- 3 db(A) at 1 Mtr distance.
Vibration level	As per approved industrial standard
Degree of superheat in evaporator	Appro.3℃
Degree of sub cooling in condenser	Appro.5℃
Grade of lubrication oil	Mineral/160P
Lubrication oil charge	6.6 per comp.
Refrigerant line size	2 X 1 5/8 inch (gas line)

	2 X 7/8 inch (liquid line)
Compressor inbuilt protection	Provided
CONDENSER	
Condenser Module	09018TX-4P
Condenser model QTY./unit	2
Manufacture	Voltas ltd
Type :	Water cooled Shell & Tube flooded
d) No. of Passes (On water side)	4
Shell Material:	IS2062 GR A
Tube sheet Material :	IS 2062GR A / IS3589
Tube Material :	Replaceable Seamless Copper tubes
Tube Size (diameter at plain end) (mm): Please specify	19.05
Type of fins Integrally & Externally finned	Enhanced Finned Copper (Internally Grooved, Externally Enhanced)
Tube thickness (plain end) (mm	1 MM
Fin material : Cu	Copper
Water Flow CMH : 30 / 132 USGPM	To match required flow rate of 132 usgpm required cooling water inlet is 33.2°C at 100 % load operating condition
Water velocity (m/sec):	Max 2.5
Pressure Drop through Condenser (bar) : Please specify	<0.6 bar
Water IN/OUT Temperature deg. C	32 / 36
Differential temperature deg. C	4
Fouling Factor MKS ≤ 0.0002	0.000018 m2k/w
Nozzle Size of In / Out of Water (NB): Please specify	Refer GA drawing
Design pressure :	Design pressure – Shell side -330 PSIG
	Design pressure – Tube side- 125 PSIG
Test pressure	Test Pressure - Shell side (pneumatic) 375 PSIG Đest Pressure - Tube side (pneumatic)150 PSIG
INSPECTION	**AS PER APPROVED VOLTAS QAP**
PAINTING:	Epoxy painted Siemens grey RAL 7032 type

INCLUDE UNDER ELECTRICAL PROTECTION:	
1 Phase Unbalance	- Provided
Phase Loss -	Provided
Phase Reversal -	Provided
Overload, under/over -	Provided
Voltage and supply failure -	Provided
Sensor Error - Provided	Provided
Major Component Make_	
) Electronic Expansion Valve	Thermostatic danfoss or equivalent
Pr. Relief valve evaporator :	As per approved Voltas vendor
Temperature sensor	As per approved Voltas vendor
Pressure sensor	As per approved Voltas vendor
Control Panel	Soft hard/equivalent
ACCESSORIES	
1 Purge and drain connections	provided
2 Isolating valves	Liquid line strainer shall be provided with Isolation arrangement (Ball valve before & after strainer) for ease of maintenance.
3 flow switches	HP & LP SWITCH PROVIDED
4 Pressure & temperature indicators at inlet and outlet	Digital Display of all digital inputs & output such as Outlet temperature for Chillers, Current, and Voltage &Compressor run hours, low water flow.
5 Anti-freeze thermostats	Thermister provided
6 Thermostatic expansion valve or float assembly as applicable	provided
7 Pilot solenoid valve	provided
8 Relief valves	provided
9 Operating thermostats for capacity control	provided
UNIT DIMENSION & WEIGHTS	
Length.(MM)	1500
Width.(MM)	850
Height.(MM)	1150
Operating wt.(KG.)	1072
Refrigerent charge QTY. (Kgs)	Nill
*Capacity rated at design condenser water inlet temp.of 32,water side fouling factor of 0.000044m2.deg.C/W and for SST of 7.2.	
Power & control supply voltage is 340-440V & 210-240 V respectively and frequency 50HZ.	
Cable size requires is 3.5C X 50 SQ MM in Aluminium	

VOLTAS LIMITED
EM&R Business Group
A TATA Enterprise

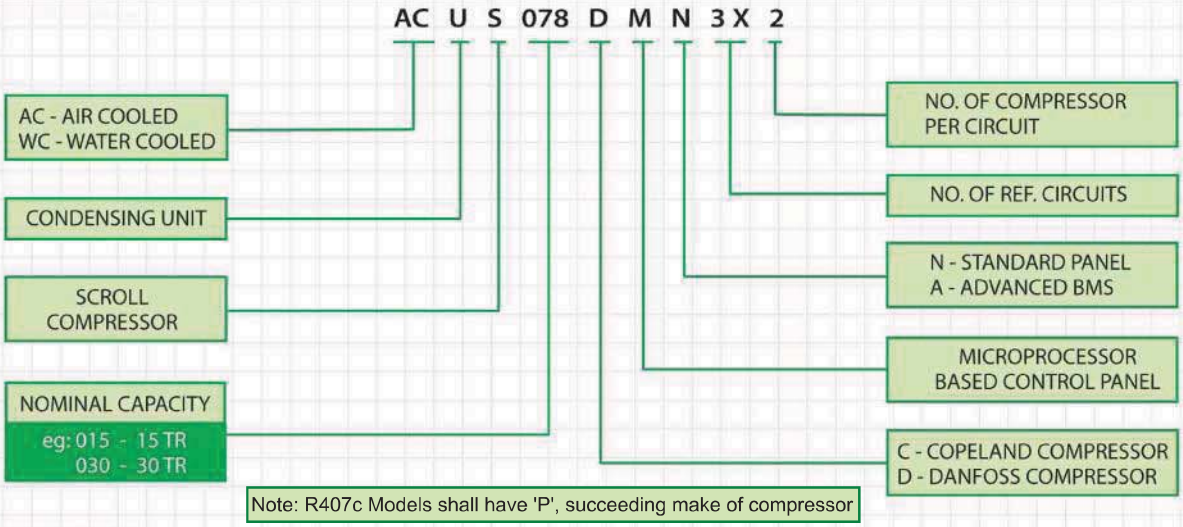
WATER-COOLED SCROLL CONDENSING UNIT

AIR-COOLED SCROLL CONDENSING UNIT

R22 / R407c

Electro-mechanical & Refrigeration Business Group of Voltas, an ISO 9001 company, is pioneer and leader in India in the field of electromechanical & refrigeration. As a result of its commitment to provide customers the technology that suits their requirements and 'best value for money', Voltas Condencing Units with Scroll Compressors have become an ideal choice for various air conditioning applications and are available in wide range of capacities.

MODEL NOMENCLATURE



Note: R407c Models shall have 'P', succeeding make of compressor

FEATURES

Hermatic Scroll Compressor

- Sourced from reputed international manufacturer
- Enhanced relaibility and extended life with no contact scroll design and motor, cooled by suction gas
- Higher energy effeciency in hermatic design
- Oil sight glass & drain port available
- Crankcase heaters provided
- Tandem design available in higher capacity units with proper design of suction & discarge header and oil equilization circuit

Compressor Drive

- Squirrel cage induction motor Total Enclosed Fan Cooled (TEFC) or Screen Protected Drip Proof (SPDP) constructions are available

Water Cooled Condensers

- Manufactured incorporating latest technology from world renowned heat exchanger manufacturer
- State of art technology makes the unit highly compact and heat energy efficient, using most advanced IGT tubes

Air Cooled Condensers

- Air cooled condensers are manufactured using IGT tubes with slotted louvered fins resulting compact units
- Each coil pneumatically tested
- High effeciency multiple blade fans driven by IP 55 motors
- Smallest footprint saves your space by V configuration of unit structure

Microprocessor Control Panel for user-friendly operation

- Three mode options are available: Programmed Mode, Auto Mode & Test Service Mode
  - Programmed Mode : Auto start & stop, programmable for entire year. This minimises operator interface
    This mode facilitates auto restart on power restoration after a load shedding or grid supply failure
  - Auto Mode : Manual single button to be used for start and stop, reset operation sequence is programmed automatically
  - Test Service Mode : Facilitates testing of the unit under supervision, for service or default detection
- All operating parameters & safety limits can be pre set as per customer application

Standard Microprocessor Panel

LCD and Key Pad of Microprocessor

Displays with diagnostic capabilities

- Digital Display of all vital parameters such as
  - Room temperature
  - Suction, Discharge & Oil Pressure of compressor
  - Current
  - Voltage
  - Compressor run hours

Capacity Control & reduction in energy consumption

- The electronic temperature sensor measures the temperature precisely and provide feedbacks to microprocessor. Based on this precise data and actual load requirements, microprocessor monitors individual compressor ON/OFF cycling for optimum operation to best effeciency of the plant

Safety & Protection

- Microcomputer Motor Protction device (µMPD) and Microcomputer Voltage Protection Device (µVPD) protect condensing unit from phase unbalance, phase loss, phase reversal, overload, under/over voltage and supply failure
- Programmed safety features available using sensitive, accurate temperature transducers & pressure switches which protects the system from:
  - High Pressure
  - Anti Recycle
  - Low Room Air Temperature
  - Low Pressure
  - Sensor Error
- Maintenance trip for compressor 50 hours before completion of 8000 hours of operation
- Alarm history of last 5 faults with date, time and cause of failure

Optional Features offered

- Dual mode chillers for thermal storage system
- Communication port RS 485 for remote connectivity, status and fault indication
- Advanced BMS compatibility with ASCII or RTu MODBUS protocol can be linked to Integrated Building Management Systems (IBMS)
- Limited hardware BMS for remote control and operation

AIR-COOLED SCROLL CONDENSING UNIT

TECHNICAL DATA SHEET (R 22)

UNIT MODEL	ACUS013DMN1X1	ACUS026DMN2X1	ACUS039DMN3X1	ACUS052DMN2X2	ACUS078DMN3X2
*Nominal cooling capacity -TR	13	26	39	52	78
COMPRESSOR					
Compressor type	Hermatic scroll				
Compressor model	SM185	SM185	SM185	SM185	SM185
Compressor qty.	1	2	3	4	6
RPM	2900	2900	2900	2900	2900
Unit capacity reduction steps in %	100	100 /50	100 /66/33	100 /75/50/25	100 /83.3/66.7/ 50/33.3/16.7
Oil type	Mineral / 160 P				
Oil charge / compr (Ltr.)	6.6	6.6	6.6	6.6	6.6
Unit max. starting current -amps at 400 volts	175	206.6	231.6	263.2	319.8
Max. allowable operating current per compr. -amps at 400Volts	35	35	35	35	35
CONDENSER					
Condenser module	9AB12	9AV20-16FPI	9AV35-3ckt 16FPI	9AV20-16FPI	9AV20-16FPI
Condenser module XQTY.	1	1	1	2	3
Fan qty.	4	2	2	4	6
Total CFM	10,000	26,000	24,000	52,000	78,000
UNIT DIMENSION & WEIGHTS					
Length.(MM)	2400	2536	2536	2642	3710
Width .(MM)	650	1270	1270	2236	2236
Height.(MM)	1390	2310	2310	2335	2335
Operating Wt. (KG.)	1035	1343	1675	2386	3280

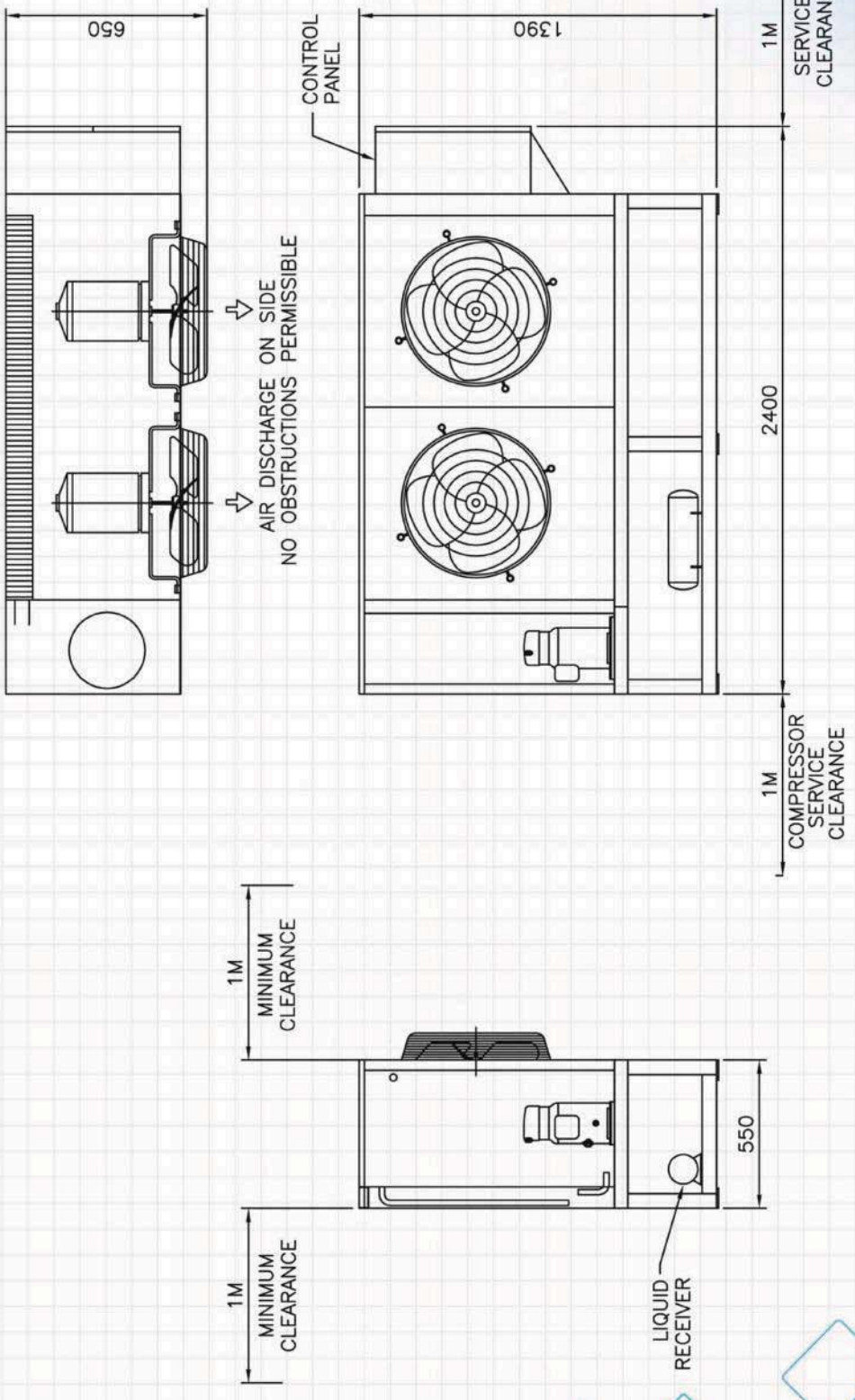
*Capacity rated at design ambient of 35 °C and for SST of 7.2 35 °C

Power & control supply voltage is 340 - 440 V & 210-240 V respectively and frequency 50Hz

Note : For higher ambient application pl. refer to EM&R BG Engg.
Similar capacity R407c Models available with Refrigerant designation 'P'

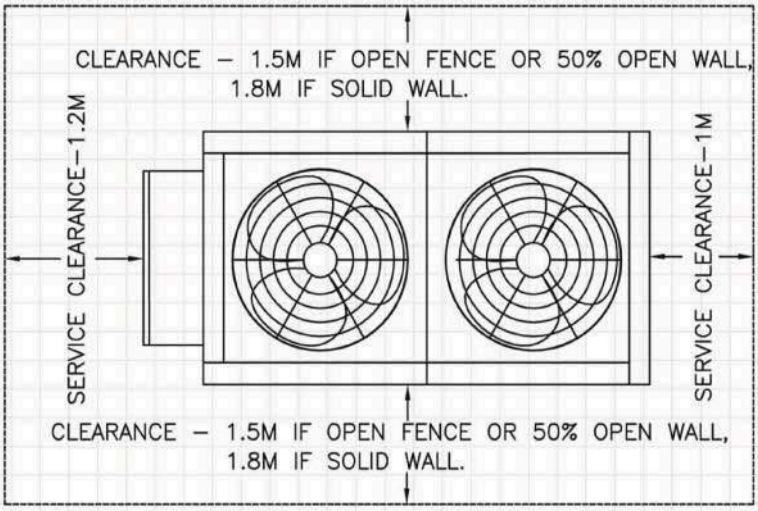
G. A DRAWING OF A/C SCROLL CONDENSING UNIT

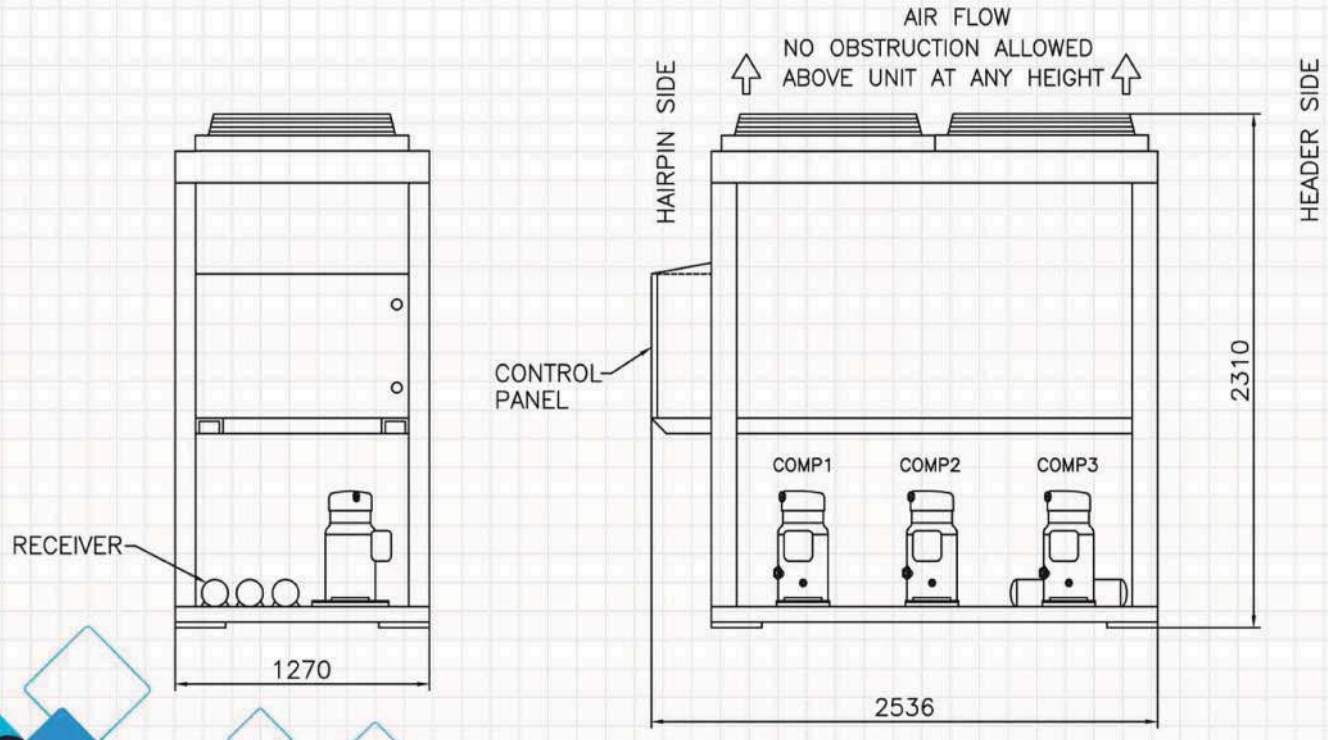
MODEL	ACUS013DMN1X1
COND.COIL	9AB12 – 1 NO.
COMPRESSOR	1x SM185
FANxHPXQTY.	ø24"X0.5X2 NOS.



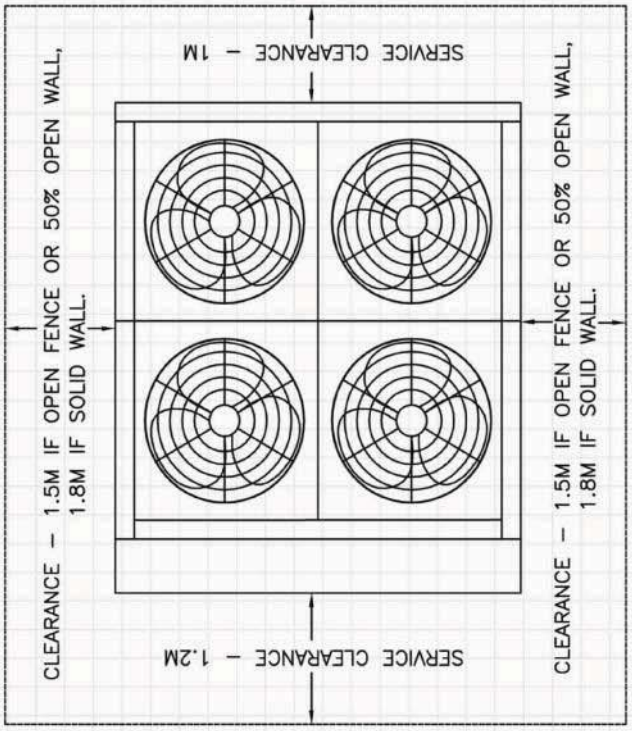
G. A DRAWING OF A/C SCROLL CONDENSING UNIT

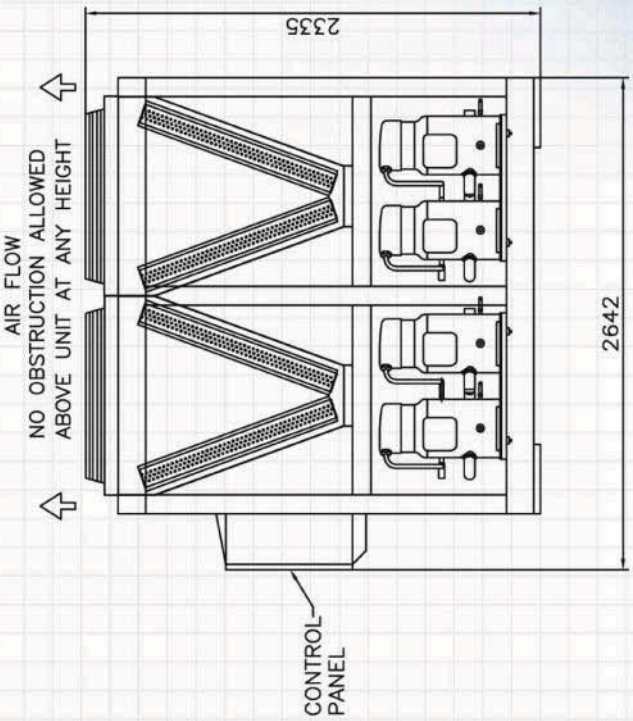
MODEL	ACUS026DMN2X1	ACUS039DMN3X1
COND.COIL	1x9AV20	1x9AV35-3CKT
COMPRESSOR	2XSM185	3XSM185
FANxHPXQTY.	ø34x3x2	ø34x3x2



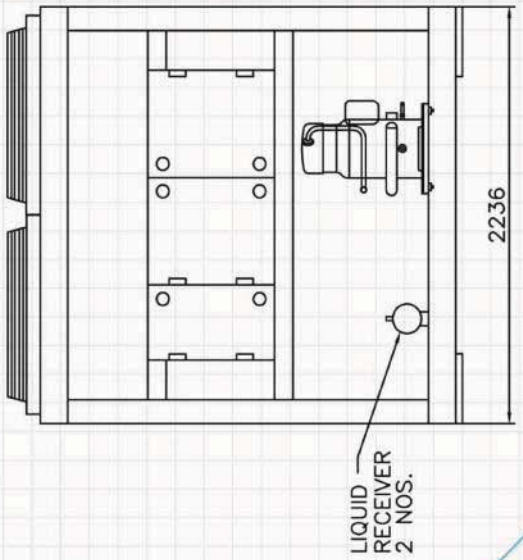


G. A DRAWING OF A/C SCROLL CONDENSING UNIT

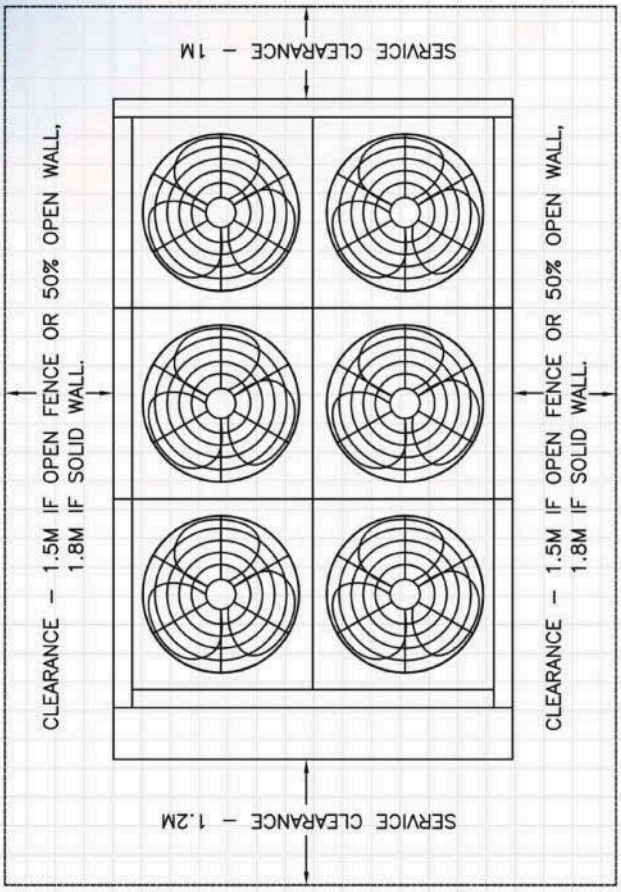


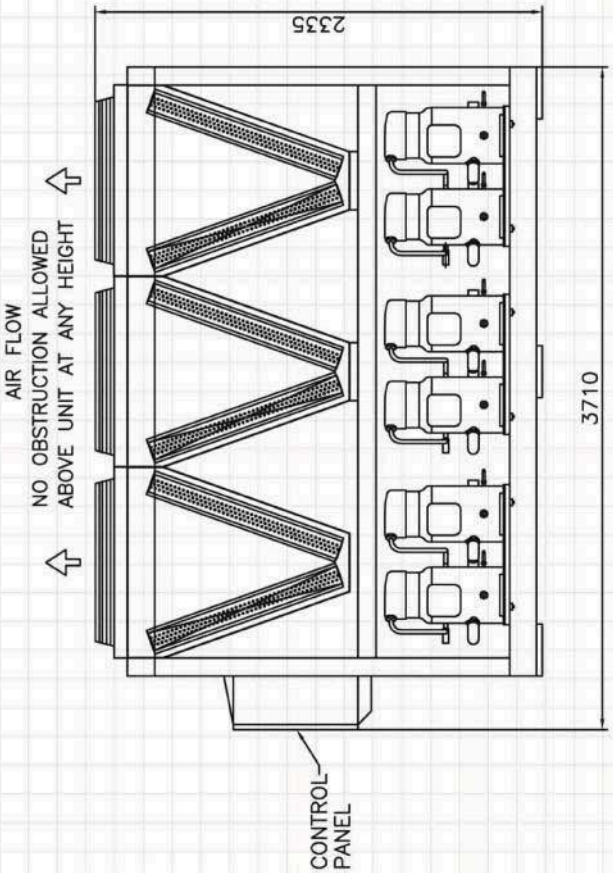


MODEL	ACUS052DMN2X2
COND.COIL	2x9AV20
COMPRESSOR	4XSM185
FANxHPXQTY.	ø34x3x4

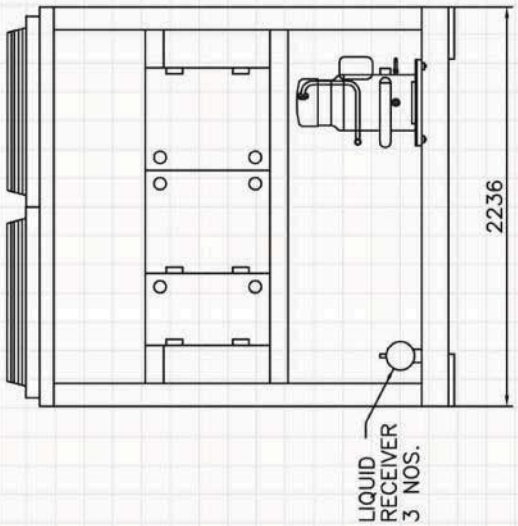


G. A DRAWING OF A/C SCROLL CONDENSING UNIT

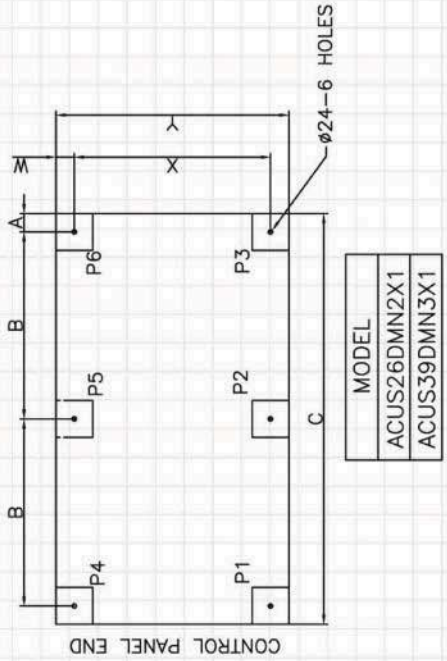




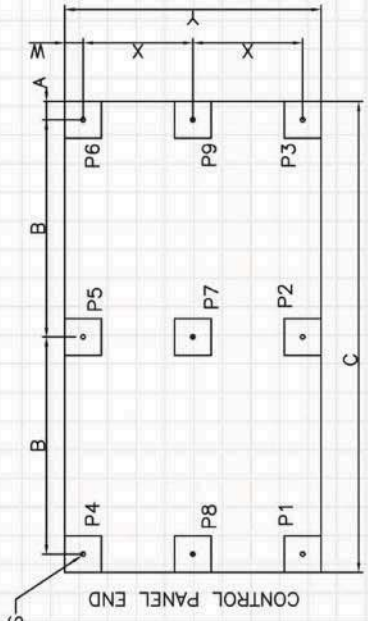
EQUIPMENT	MODEL ACUS078DMN3X2
COND.COIL	3x9AV20
COMPRESSOR	6XSM185
FANxHPXQTY.	ø34x3x6



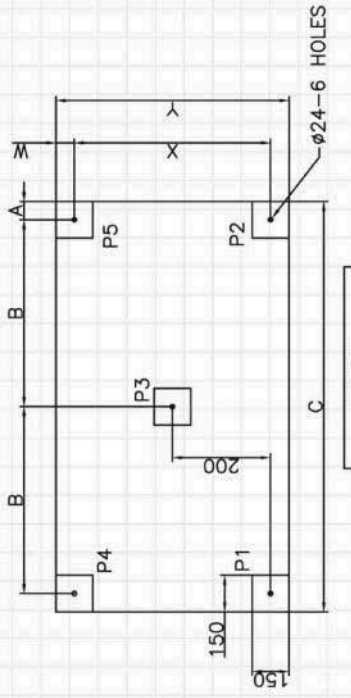
POINT LOAD DIAGRAM OF A/C SCROLL CONDENSING UNIT



MODEL
ACUS26DMN2X1
ACUS39DMN3X1



MODEL
ACUS052DMN2X2
ACUS078DMN3X2



MODEL
ACUS13DMN1X1

MODEL	PAD LOCATION IN MM.						LOAD PER POINT – KG.								
	A	B	C	W	X	Y	P1	P2	P3	P4	P5	P6	P7	P8	P9
ACUS013DMN1X1	75	975	2100	75	400	550	180	180	240	210	195	–	–	–	–
ACUS026DMN2X1	75	1043	2236	75	1120	1270	157	137	108	157	152	167	467	–	–
ACUS039DMN3X1	75	1043	2236	75	1120	1270	255	110	100	260	210	190	550	–	–
ACUS052DMN2X2	100	1068	2336	100	1018	2236	254	254	254	254	254	254	354	254	254
ACUS078DMN3X2	100	1603	3406	100	1018	2236	370	370	370	370	370	370	370	345	345

WATER-COOLED SCROLL CONDENSING UNIT

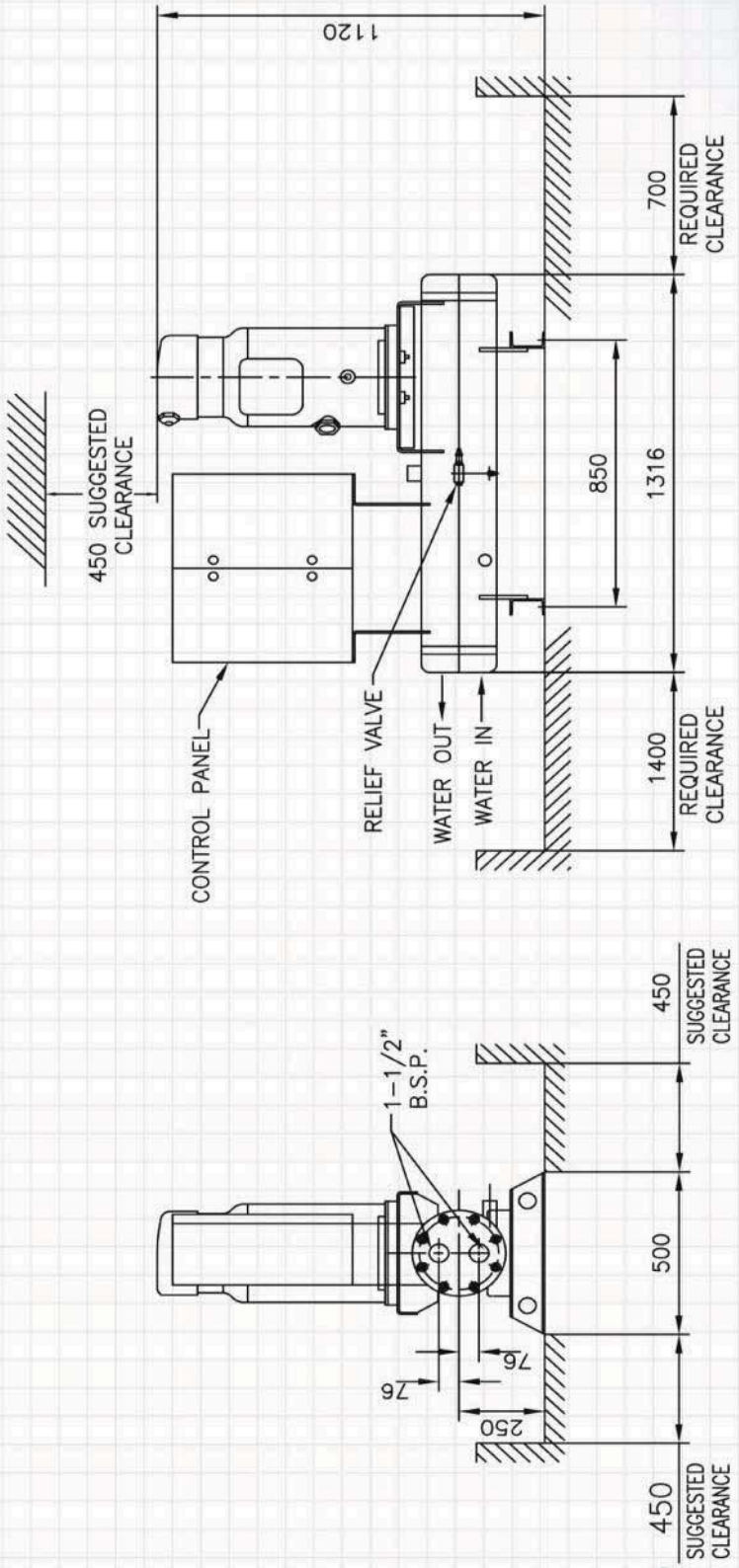
TECHNICAL DATA SHEET (R 22)					
UNIT MODEL	WCUS014DMN1X1	WCUS028DMN2X1	WCUS042DMN3X1	WCUS056DMN2X2	WCUS084DMN3X2
*Nominal cooling capacity -TR	14	28	42	56	84
COMPRESSOR					
Compressor Typee	Hermatic scroll				
Compressor model	SM185	SM185	SM185	SM185	SM185
Compressor qty.	1	2	3	4	6
RPM	2900	2900	2900	2900	2900
Unit capacity reduction steps in %	100.00	100/ 50	100/ 66/33	100 /75/50/25	100/83.3/66.7 /50/33.3/16.7
Oil type	Mineral / 160 P				
Oil charge/compr.,Liter	6.6	6.6	6.6	6.6	6.6
Unit starting current -amps at 400 volts	175	206.6	231.6	263.2	319.8
Max. allowable operating current per compr. -amps at 400Volts	35	35	35	35	35
CONDENSER					
Condenser Module	09018TX -4P	09018TX -4P	09018TX -4P	9036	9036
Condenser module qty/unit	1	2	3	2	3
Cond. Water flow rate (USGPM)	54	108	162	216	324
UNIT DIMENSION & WEIGHTS					
Length.(MM)	1316	1500	1900	2500	2500
Width.(MM)	500	850	850	850	1300
Height.(MM)	1120	1150	1150	1400	1500
Operating wt.(KG.)	661	1072	1450	1580	2352

*Capacity rated at design condenser water inlet temp.of 32 °C,water side fouling factor of 0.000044 m2.deg.C/W & for SST of 7.2 °C ; Power & control supply voltage is 340 - 440 V & 210-240 V respectively and frequency 50Hz

Note : For higher ambient application pl. refer to EM&R BG Engg.

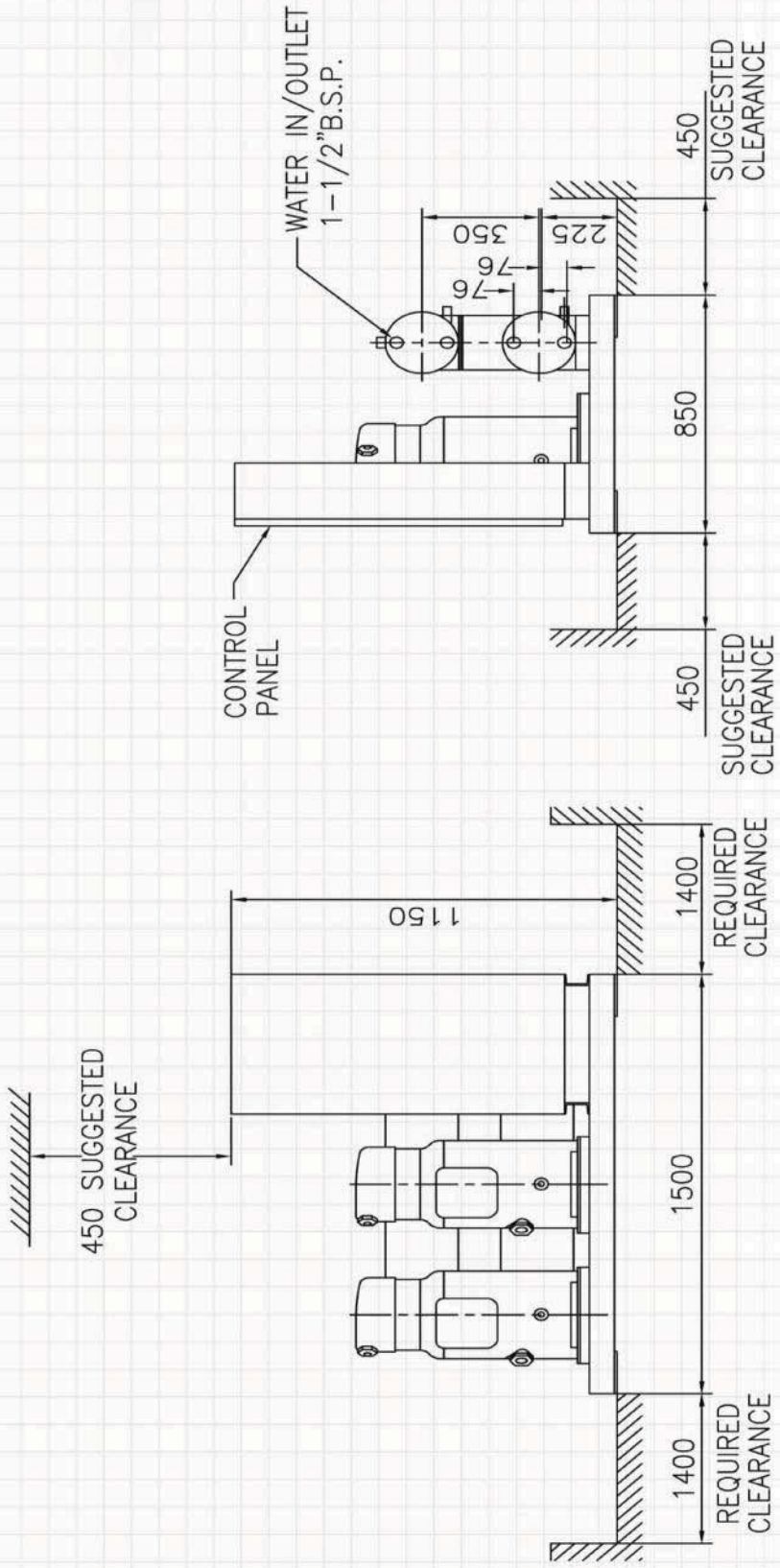
G. A DRAWING OF W/C SCROLL CONDENSING UNIT

MODEL	WCUS014DMN1X1
CONDENSER W/C	1x09018TX-4P
COMPRESSOR	1xSM185



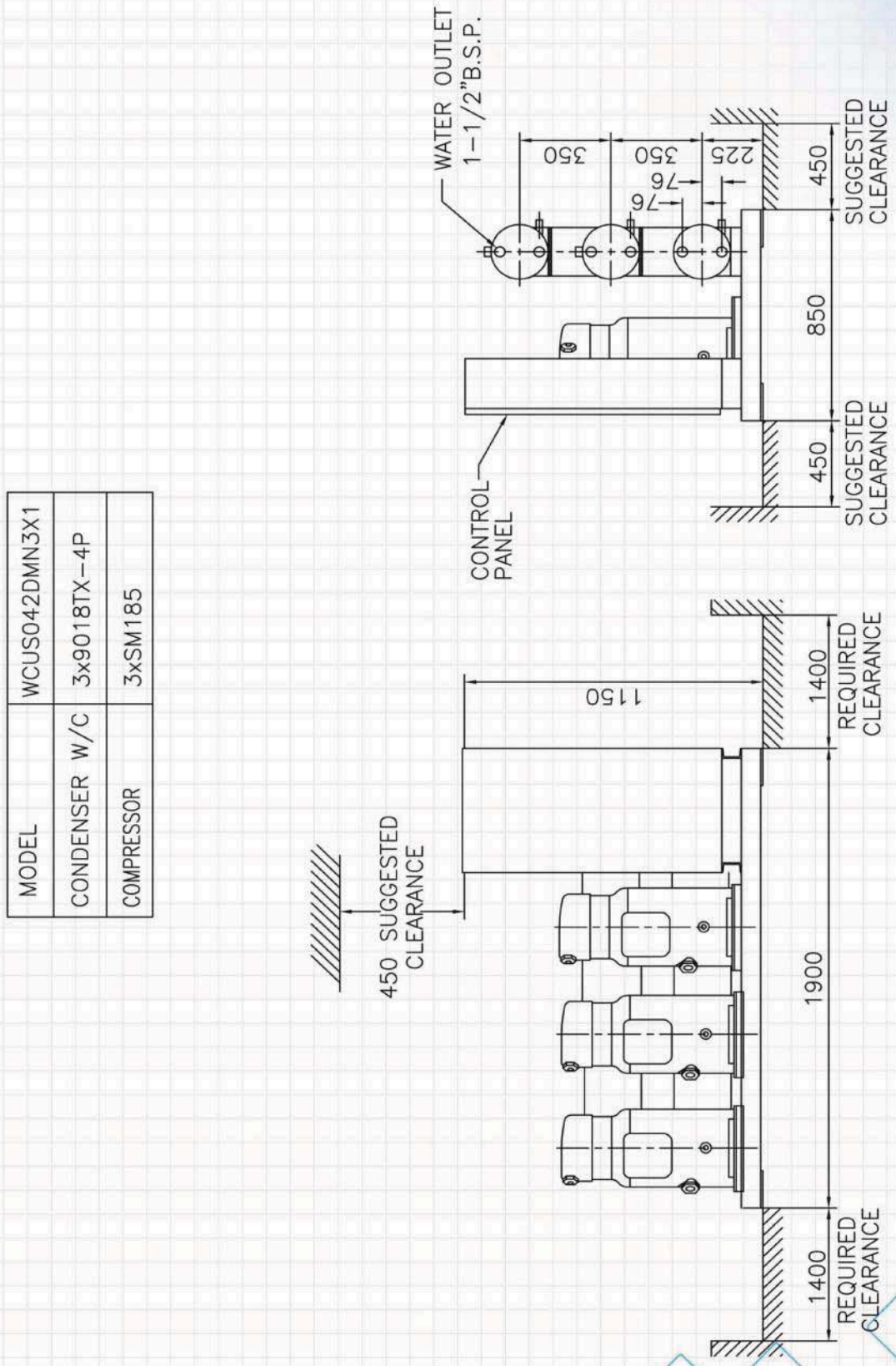
G. A DRAWING OF W/C SCROLL CONDENSING UNIT

MODEL	WCUS028DMN2X1
CONDENSER W/C	2x9018TX-4P
COMPRESSOR	2xSM185



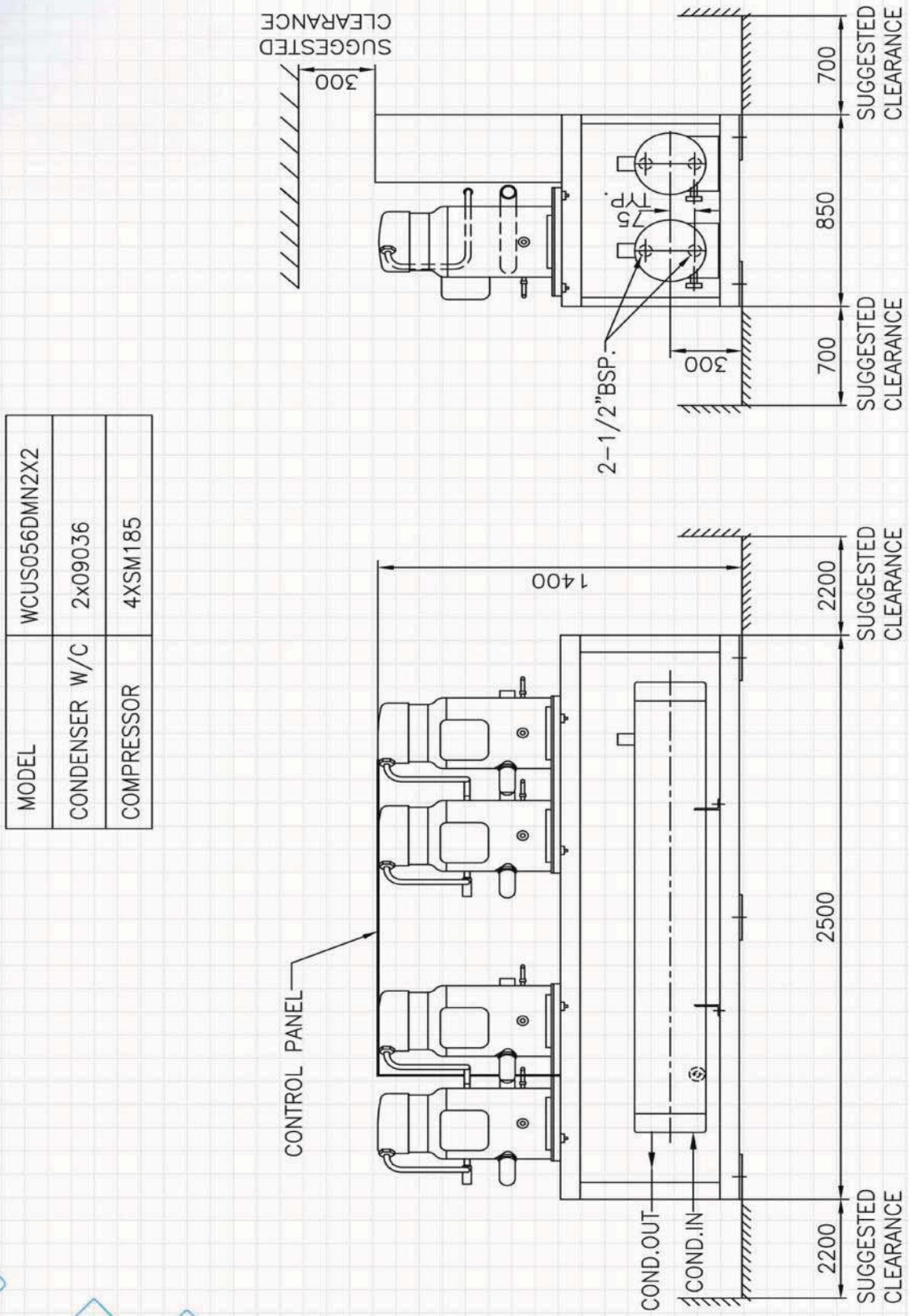
G. A DRAWING OF W/C SCROLL CONDENSING UNIT

MODEL	WCUS042DMN3X1
CONDENSER W/C	3x9018TX-4P
COMPRESSOR	3xSM185



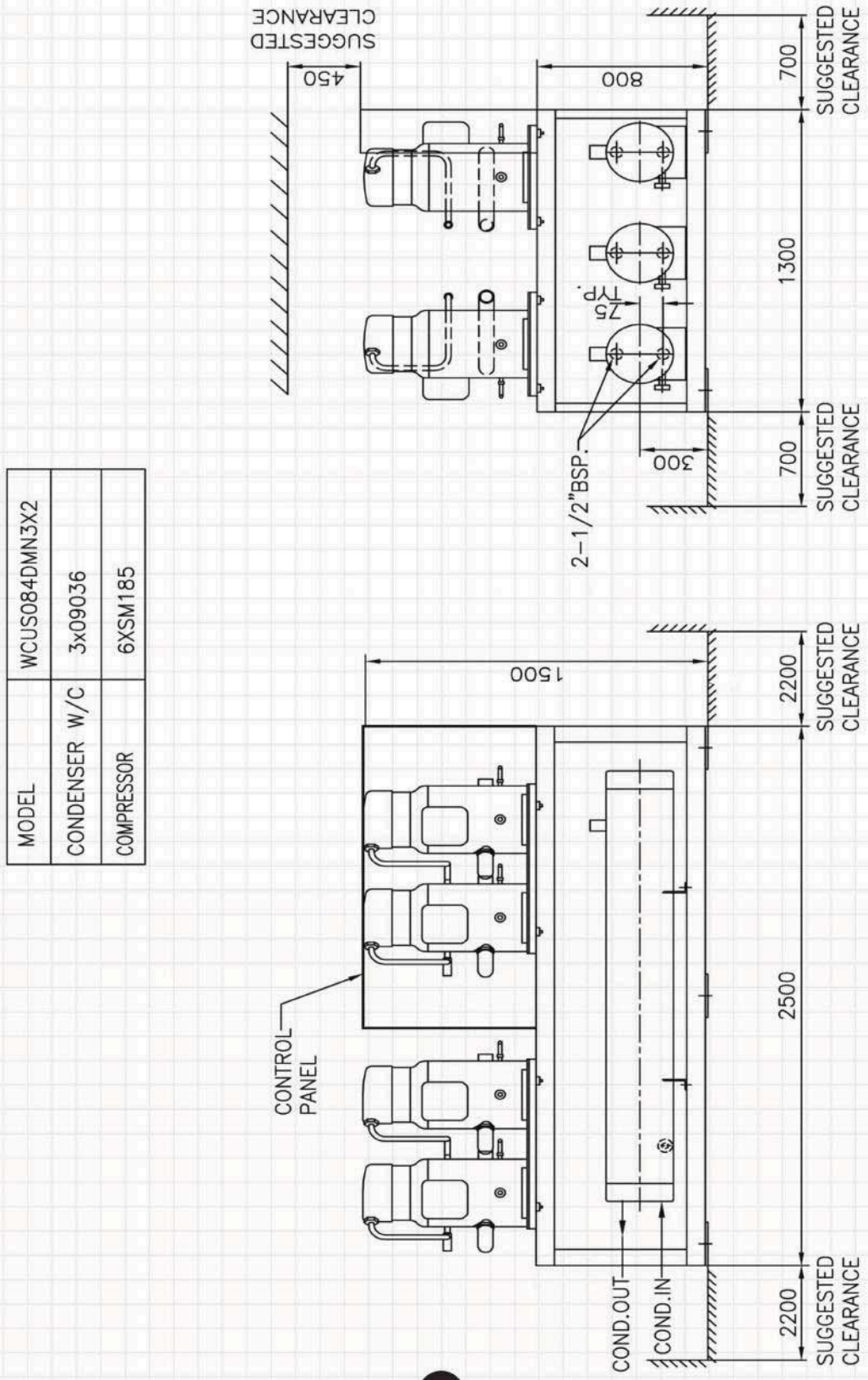
G. A DRAWING OF W/C RECIPROCATING CONDENSING UNIT

MODEL	WCUS056DMN2X2
CONDENSER W/C	2x09036
COMPRESSOR	4XSM185

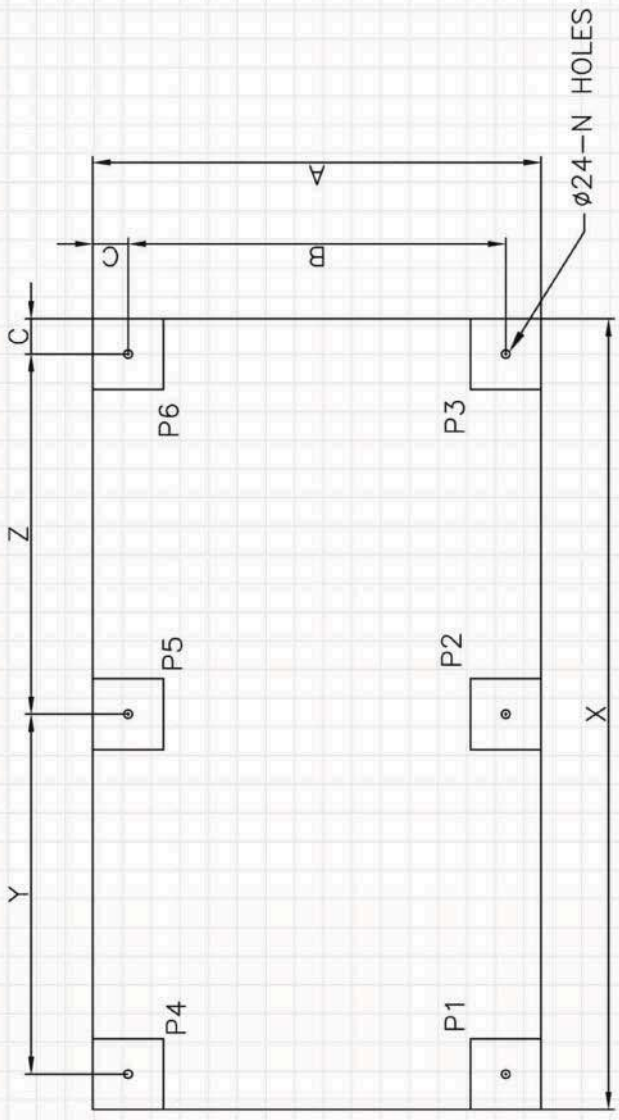


G. A DRAWING OF W/C RECIPROCATING CONDENSING UNIT

MODEL	WCUS084DMN3X2
CONDENSER W/C	3x09036
COMPRESSOR	6XSM185

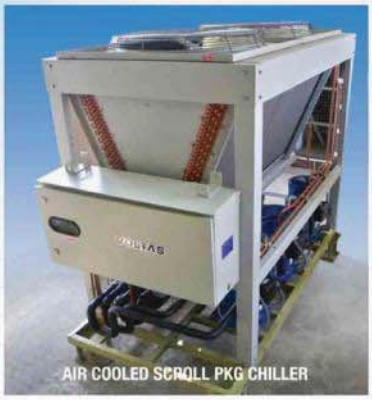


POINT LOAD DIAGRAM OF W/C RECIPROCATING CONDENSING UNIT

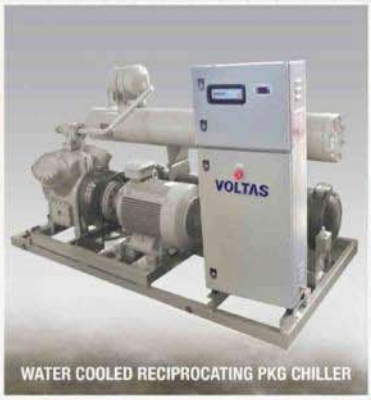


MODEL	LOAD PER POINT – KG.											
	A	B	C	X	Y	Z	N	P1	P2	P3	P4	P5	P6
WCUS014DMN1X1	–	400	–	–	850	–	4	164	–	159	159	–	179
WCUS028DMN2X1	850	700	75	1500	1350	–	4	258	–	258	278	–	278
WCUS042DMN3X1	850	700	75	1900	875	875	6	245	175	245	290	215	280
WCUS056DMN2X2	850	650	100	2500	1075	1075	6	280	330	280	230	230	230
WCUS084DMN3X2	1300	1100	100	2500	1150	1150	6	417	417	417	417	367	317

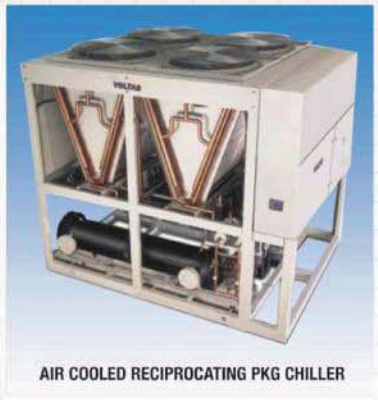
HVAC PRODUCT RANGE



AIR COOLED SCROLL PKG CHILLER



WATER COOLED RECIPROCATING PKG CHILLER


AIR COOLED RECIPROCATING PKG CHILLER


ENERGY EFFICIENT
AIR COOLED SCREW CHILLER


ENERGY EFFICIENT
WATER COOLED SCREW CHILLER


WATER COOLED SCREW CHILLER

WATER COOLED SCROLL CHILLER

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DOUBLE EFFECT VAM


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VARIABLE REFRIGERANT FLOW SYSTEM (VRF)


AIR HANDLING UNIT (AHU)

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	011 66505570	26950081
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Gurgaon	0124 5060504	
Jaipur	0141 25179983	2213728
Jalandhar	0181 2227687	
LUCKNOW (Branch)	0522 2238538	2238532
	0522 2237856	
Dehradun	0135 2750401	
WESTERN REGION		
AHMEDABAD (Branch)	079 66301107	66301199
	079 66301108	
Ankleshwar	02646 238199	
Rajkot	0281 2578124	
Silvassa	0260 2640363	
Surat	0261 2422761	
Vadodara	0265 2351706	2332098
MUMBAI (Branch)	022 66656757	66656797
	022 66656761	66656768
Goa	0832 2463664	
Indore	0731 2498616	
Nagpur	0712 5618846	
Nasik	0253 2455169	
PUNE (Branch)	020 66046602	66046600
	020 66046603-5	66046601
Aurangabad	0240 2320510	

OFFICE	TELEPHONE	FAX
EASTERN REGION		
JAMSHEDPUR (Branch)	0657 2431062	2432201
	0657 2434322	
Patna	0612 2232717	
Raipur	0771 5059303	
KOLKATA (Branch)	033 66266283	22300108
	033 66266264	
Bhubaneshwar	09437178427	
Cuttack	0671 2332366	
Guwahati	0361 2340519	
SOUTHERN REGION		
BANGALORE (Branch)	080 67132500	22270172
	080 67132504	22998508
Mangalore	0824 2453316	
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	044 66760375	
Coimbatore	0422 2241188	2218771
	0422 2244384	
Madurai	0452 2535818	
HYDERABAD (Branch)	040 66500407	66203882
	040 66500451	
Vijaywada	0866 2435282	2431507
Vishakhapatnam	0891 2754051	2570864
	0891 2754665	
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REASON FOR RESUBMISSION: NO COMMENTS FROM TANGEDCO / DESEIN RECEIVED ON REV. 0 DOCUMENT. ADDITIONAL DETAILS ARE INCLUDED IN THE DOCUMENT. SUBMITTED FOR APPROVAL PLEASE.

DOCUMENT IS APPROVED VIDE TANGEDCO LETTER NO. SE/E/TH&HYP/EE-7/M/AEE/M/F.EN SEZ STPP/D.726 /18 DT. 01.12.2018

BHARAT HEAVY ELECTRICALS LIMITED
PROJECT ENGINEERING MANAGEMENT
(MECHANICAL AUXILIARY)

This approval status shall be interpreted as laid down in the contract and it shall not relieve the contractor from his contractual obligation.

APPROVAL CATEGORY AWARED = I

CAT I - Approved
CAT II - Approved with Comments as Noted
CAT III - Not Approved
CAT IV - Reference Drawing

Name: VIPIN NAUNI
Signature:

VIPIN NAUNI
Reviewed by BHEL and found in order. Submitted for TANGEDCO / Desein Approval.
2018.11.21 10:54:46 +05'30'

Date	Rev	Description of Revision	ALT	CHD	APPD
16/11/2018	01	AS PER BHEL COMMENTS	ALAM	SALIM	SKT
06/11/2018	0A	AS PER BHEL COMMENTS	ALAM	SALIM	SKT
28/09/2018	00	FIRST SUBMISSION	ALAM	SALIM	PC

PROJECT	2x660 MW ENNORE SEZ COAL BASED STPP AT ASH DYKE OF NCTPS, CHENNAI
	CUSTOMER TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED (TANGEDCO)
	CONSULTANT **DESEIN PRIVATE LIMITED** **DESEIN HOUSE, GREATER KAILASH-II, NEW DELHI**
	EPC CONTRACTOR BHARAT HEAVY ELECTRICALS LTD PS-PEM, PPEI-BUILDING, SECTOR-16A, PLOT NO. 25, NOIDA-201301

STATUS	**CONTRACT**	**DOC. NO: PE-V0-412-553-A018**	Rev: 01
PACKAGE		**AIR CONDITIONING SYSTEM**	
TITLE		**TDS & GA of Cooling tower along with foundation details**	

COOLING TOWER FOR ESP BUILDING

TECHNICAL DETAILS FOR INDUCED DRAFT COUNTER FLOW COOLING TOWER			
Sno.	**Description**	**Unit**	**Details**
1.1	**Project**		**2X660 MW ENNORE TPS**
1.2	**Customer**		**TANGEDCO**
1.3	**Consultant**		**DESEIN**
1.4	**EPC Contractor**		**BHEL**
1.5	**AC Supplier**		
1.6	**Location of Cooling Tower**		**ESP-1&2**
2.1	Nos. Of CoolingTower	Nos.	2
2.2	Cooling Tower Make		FlowTech
2.3	Model of Cooling Tower		RE0504-2L-ID
2.4	Type of Cooling Tower		Counter Flow Type Cooling Tower
2.5	Structure		FRP
2.6	Water Flow Rate	CMH	30
2.7	Designed Water Flow Rate	CMH	33
2.8	Inlet Water Temperature	Deg. C	36
2.9	Outlet Water Temperature	Deg. C	32
2.10	Design Wet bulb Temperature	Deg. C	28
2.11	Design Approach	Deg. C	4
2.12	Heat Rejection Capacity	Kcal/hr	131725
2.13	Maximum Drift Loss	% (CMH)	0.02
2.14	Evaporation Loss	% (CMH)	0.7
2.15	Blow-down Loss (Assuming COC 3)	% (CMH)	0.36
2.16	Make-up Water Quantity	% (CMH)	1.08
2.17	No. of Cell per Tower	No.	1
	Required Pumping Head Including all losses measured at normal water level of basin	MWC	
2.18	Tower Size		1650 x 1350 x 3150
2.18.1	Length	mm	1650
2.18.2	Width	mm	1350
2.18.3	Overall Height	mm	3150
2.18.4	Static Height up to centerline of water inlet header	mm	2300
2.18.5	Basin Working Volume	cum	0.45