NEW NYVELI LIGNITE CORPORATION LTD

2x500 MW NEW NEYVELI TPP
(SG-PACKAGE)

VOLUME II B & III

TECHNICAL SPECIFICATION
FOR
AIR CONDITIONING SYSTEM (SG-PACKAGE)

Specification No. PE-TS-400-553-A001 Rev 01

DECEMBER 2015

BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERIING MANAGEMENT
NEW DELHI

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VOLUME – IIB

VOLUME-III

VOLUME II B

SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design, engineering, manufacture, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation, storage, preservation , security / safety at site , Erection & Commissioning, minor civil & structural (as applicable) works as required on FOR site basis, Performance and guarantee testing / demonstration testing and handing over to BHEL's customer of **AIR CONDITIONING SYSTEM** as per details in different sections / volumes of this specification and various pre award agreements for **2X500 MW NNTPP SG-PACKAGE**.

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 tems 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 Vol-III 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 Vol – III); 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, Section - C shall prevail over 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 referred relevant clause.

SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

SALIENT FEATURES OF THE SITE & GENERAL PROJECT INFORMATION

1.1 Introduction

The project site at Neyveli has distinct location advantages, being at pit-head distance from the source of lignite supply from Mines, making it convenient for transportation of lignite by belt conveyor. Water source is readily available from the nearby mines lake. Besides, other infrastructure such as access road, railway connection etc, already exist.

1.2 Power Plant Site

The power plant site is located at Neyveli, opposite to the now defunct Fertilizer and Briquetting & Carbonization Plant, near TPS-I Expansion and TPS-II.

1.3 Project & Site Information

(i).	Owner / Purchaser	:	Neyveli Lignite Corporation Limited (NLC Ltd), Neyveli, Cuddalore District, Tamil Nadu State, India
(ii).	Consultant	:	Lahmeyer International (India) Pvt. Ltd (LII), Gurgaon, NCR, India.
(iii).	Project Title	:	2x500 MW Neyveli New Thermal Power Project (NNTPP)
(iv).	Location	:	200 kms south of Chennai and 50 kms south-west of Cuddalore
(v).	Latitude	:	11° 34′ 00″ N to 11° 35′ 00″ N
(vi).	Longitude	:	79° 26′ 00″ E to 79° 27′ 00″ E
(vii).	Elevation above MSL	:	(+) 67 m
(viii).	Nearest Railway Station	:	Neyveli,
(ix).	Nearest Sea Port	:	Chennai, at a distance of 200 km
(x).	Nearest Airport	:	Chennai, at a distance of 200 km
(xi).	Road Access/Approach to Site	:	Connected by Chennai-Thanjavur NH 45C road and state highway connecting Cuddalore – Virudhachalam via Neyveli. Both NH and state high way roads are well connected to NLC township roads. The approach road is approximately 15 kms from Chennai–Thanjavur NH – 45C road
(xii).	**Site Meteorological Data**		
	• Max ambient temperature	:	42.8° C
	• Min Ambient Temperature	:	26.9° C

• Wet bulb temp	:	29° C
• Max. Relative Humidity	:	92 % in the month of September
• Min. Relative Humidity		23 % in the month of May
• Rainfall		About 1265.7 mm annually (average)
• Wind direction		South West to North East direction
• Wind Speed		97.2 km/hr (maximum recorded) 4.3 km/hr (average wind speed)
• Seismicity		As per IS: 1893 (part 4) (Zone-II) Importance factor: 1.75.

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NLC LTD NEYVELI

S.No	Description	SILL Value
	• RCC floors (Offices, laboratories, conference rooms and general floors)	5 kN/m^2
	• Balconies	5 kN/m^2
	• Chequered plate / gratings	5 kN/m^2
	• Walkways	3 kN/m^2
	• Toilets	2 kN/m^2

- In addition to LL, Hung loads for electrical, ventilation & air conditioning minimum of 0.5 kN/m^2 shall be considered.
- Load of 1 kN/m^2 shall be considered as hung load for piping unless otherwise mentioned. However, the actual loads will be as furnished by the supplier. The stringent most will be followed.
- For other areas LL shall be considered as per IS: 875 (Part-2).
- Ponding effects due to framing deflections for roofs, if any shall be considered.

(c) Seismic Load

The proposed plant is located in Seismic Zone-II as per IS: 1893, Seismic force on the structures will be considered accordingly.

(d) Wind Load

The proposed plant is located in Wind Speed Zone of 50 m/s as per IS: 875 (Part 3). The wind force on the structures will be considered as follows:

Table 2.3
Wind Speeds

Description	Wind Speed
Basic Wind Speed Vb (at 10m above mean ground level)	50 m/sec
Risk coefficient K1 (for 100 years)	1.07
Category of terrain	Category 1
Factor K2	As per IS: 875
Topography factor K3	As per IS: 875

For the design of structures, wind force on Equipment, supported on frame including all fixtures, piping, staircase, ladder, etc, shall be considered.

Design of structures shall be checked for the condition of wind load with gust factor.

(e) Earth Pressure Loads

For earth pressure the worst condition with dry / submerged and active, passive or at rest shall be considered. The pressure coefficient shall be adopted as recommended in Soil Report or for the backfill material used.

(f) Temperature Loads

The total temperature variation shall be considered as 2/3rd of the average maximum annual variation in temperature. The average maximum annual variation in temperature for this purpose shall be taken as the average between the mean of the daily minimum ambient temperature during the coldest month of the year and mean of daily maximum ambient temperature during the hottest month of the year. The structure shall be designed to withstand stresses due to 50 % of the total considered temperature variation with temperature load applied with positive and negative sense.

For design purpose average maximum annual variation shall be taken as +50°C to +5°C.

Coefficient of thermal expansion of steel shall be taken as per IS: 800 where the value is given as 12x10-6/°C. Coefficient for thermal expansion for concrete shall be taken as per IS: 456.

(g) Thermal Loads (during operating condition)

When thermal loads (such as produced by temperature changes in piping, equipment and structures) results in friction between equipment and supports (exchangers) or piping and supports, the friction force will be taken as the operating load on the support multiplied by the applicable friction coefficient given below:

Table 2.4
Thermal Loads

Description	Value
Surfaces	Friction coefficient
Rolling supports	0.05
Steel to steel	0.30 (longitudinal) and 0.10 (lateral)
Concrete to steel	0.30

(h) Equipment Loads

Static and dynamic loads of major equipments shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered e.g. control room floors are usually designed for a live load that includes the equipment weight also.

All equipments, tanks and piping design loading shall include hydraulic test loading. Weight of equipments, ducts, tanks, pipes, conduits, etc. supported by structure shall include maximum possible loading conditions i.e. flooded conditions and associated impacts, test loading, anchorages and constraint effects.

Air and gas duct loads shall include weight of insulation, duct attachments, dust accumulation loads, seismic, wind and other loads applicable.

(i) **Hoists, Monorail and Elevator loads**

All lifting beams and monorails shall have their design loads increased for impact factor. Loads for hoists, monorails and elevators shall be taken as per IS: 875.

100 % of the lifted load including elevator live load plus the cab weight shall be considered for the elevator support beam design. Pedestals in elevator pits shall be designed assuming 100 % impact factor.

(j) **Vibration and Noise**

The design shall ensure that vibrations from any moving machinery transmitted from its immediate foundations to adjacent buildings or areas of the same building shall be suppressed in accordance with the recommendations of relevant codes of practice. Any control room, administration facility and other permanently occupied office area shall be structurally isolated from plant areas subject to frequent shock loads or containing large oscillating or rotating plant and equipment.

(k) **Other Loads**

- Stresses imparted to structures due to differential settlements, variation of water table, erection and maintenance loads, creep and shrinkage shall also be considered in design of all structures.
- Dust loads

  All buildings / structures shall be designed for a dust load of 1 kN/m^2 for flat roof and 0.5 kN/m^2 for sloped roof.
- Construction Loads

  The integrity of the structures shall be maintained without use of temporary framing struts or ties and cable bracing as far as possible. However, construction or access considerations may dictate the use of temporary structural systems. Special studies shall be made and documented to ensure the stability and integrity of the structures during any periods involving use of temporary bracing systems.
- Future Loads

  Loads from future expansion shall be considered when so directed by the Owner/Consultant. Future loads may include any of the loads listed above.
- Surge Loads

  Surge loads may occur in some vessels or equipment. In such cases, the magnitude and direction of the load shall be given by the equipment supplier.

SECTION: C

TECHNICAL SPECIFICATIONS

SECTION: C 1
SPECIFIC TECHNICAL REQUIREMENT

1. FUNCTION

The purpose of the system is to provide Air-Conditioning for different areas of 2x500 MW NNTPP, SG PACKAGE under the scope of BHEL.

2. SYSTEM DESCRIPTION

2.1 AC PLANT-1, FOR ESP BUILDING (Common for both units)

The air conditioning plant shall comprise of (2 x 80 TR) water Cooled Screw/Scroll chillers (1 working + 1 standby). The condenser cooling water shall be circulated through these units by means of 2 x 100% horizontal/back pull out type split casing centrifugal pump sets and 2 x 100% FRP cooling towers. The chilled water produced by the chilling units shall be circulated to the air handling units by means OF 2 X 100% horizontal/back pull out type centrifugal pump sets. These AHU shall be located in AHU rooms located near by the air-conditioned areas in each ESP building. The conditioned air from AHUs shall be distributed to the air-conditioned areas by galvanised sheet steel ducting and extruded Aluminium grilles / diffusers with volume control dampers and supporting frames. The return air shall be collected above the false ceiling and led back to the AHU rooms which acts as mixing plenum for return and fresh air.

2.2 SPLIT TYPE AIR CONDITIONERS

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of control room areas having workstation for auxiliary plant. For areas requiring multiple working split ACs, One (1) No. standby (of same capacity) shall be provided. (Only those aux. control rooms which are under scope of BHEL). Local isolator / MCB shall be provided with split units.

Hand operated remote and other accessories as specified. Local Distribution Boards containing Switch / MCB shall be provided for Split Air Conditioners, and FCUs. Each split unit shall also be provided with suitable rating stabiliser.

Single phase electrical feeders of following ratings shall be provided for split units. Bidder to ensure the suitability as per these feeder requirement.

Capacity of Split AC	Single phase feeder
1.5 TR	2.2 KW
2 TR	3.0 KW

3. DESIGN CRITERIA

3.1 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

- The outside design conditions considered are as follows:-

	Summer	Monsoon	Winter
DBT (°C)	43.0	31.1	10.0
WBT (°C)	25.6	26.6	6.1

- The inside design conditions to be maintained are as follows:-

  Temp 23°C ± 1^0C & RH 55% ± 5%

- For winter heating load calculation, 50% of combined light load and eqpt./panel load as available in the room shall be considered.
- A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area.

- The Occupancy shall be considered as One (1) person in 12 sq.m in all the manned areas. Conference room One (1) person in 3 sq.m, in control room, CER etc. One (1) person in 25 sq.m (minimum).
- The air distribution system shall be sized to have a constant frictional drop along it's length and velocity through ducts shall not exceed 8.0 m/sec.
- Air and water velocity:-

i)	Main ducts: -	6 – 8	m/sec
ii)	Branch duct: -	4 – 6	m/sec
iii)	Supply air grills: -	3 – 4	m/sec
iv)	Louvers for air inlet: -	1.5	m/sec (maximum.)
v)	Water velocity in piping: -	1.5	m/sec (maximum.)
vi)	Dry panel filter (Face velocity):-	2.0	m/sec (maximum.)
vii)	Centrifugal fan at inlet/outlet: -	8 – 10	m/sec
viii)	Return air grills: -	2 – 3	m/sec

- Lighting load shall be considered as under:-

  For ESP control room minimum 2 W / Sq ft. or actual whichever is higher shall be considered.
- Fresh air requirement for air-conditioning shall be considered as under:-
- For ESP Control room 35/M3/hr/person or 1.5 air changes per hour whichever is higher.
- For other design parameters refer to clause 12.5, 12.6 of section C-2 and other relevant clauses of section C-2, customer specifications.

4. SYSTEM CAPACITY AND CONFIGURATION

4.1 AC PANT-1

2x80 TR Actual capacity Screw/Scroll Chilling machines (1 working + 1 Standby) shall be provided.

5. LAYOUT CONSIDERATIONS

5.1 AC PLANT-1

5.1.1 The central chilled water plant, Condenser Water & Chilled Water Pumps for AC Plant shall be housed in AC Plant Room at 0.0 M level near ESP-control room building unit-1.

5.1.2 The AHUs for this AC Plant would be located as under:

- 3 AHUs (3 x 50 %) for areas at 4 m i.e ESP Control room for unit-1, located in AHU Room at 4 M level adjacent to ESP Control room for unit-1.
- 3 AHUs (3 x 50 %) for areas at 4 m i.e ESP Control room for unit-2, located in AHU Room at 4 M level adjacent to ESP Control room for unit-2.

5.1.3 The Cooling Towers, Make-up water Storage Tank, Expansion Tank Storage Tanks and Water Softening plant shall be located at roof of AC plant room-1.

5.1.4 3 T Capacity Chain pulley block electrically operated with Monorail arrangement shall be provided for the AC Plant room only for maintenance purpose.

5.1.5 1 T Capacity Chain pulley block manually operated with Monorail arrangement shall be provided for each AHU room only for maintenance purpose.

6. SPECIAL CONSIDERATION

a) Water flow rate for chilled water pump selection: 0.84 cmh/TR

b) Water flow rate for condenser water pump selection: 1.08 cmh/TR

c) The system shall have 10% reserve capacity over and above the selected capacity

d) Further design margins in various equipment shall be as per relevant clauses of section C2-A, customer specifications.

e) All equipment shall be of high quality and high efficiency meeting the stipulated power consumption as defined elsewhere in the specifications.

7. AC EQUIPMENT DETAILS

7.1 Water Cooled Chiller Package:-

7.1.1 Screw/scroll type Water Chilling Packages:-

Screw/scroll type compressors (suitable for Refrigerant R-134a) with motors complete with suction and discharge shut off valves, oil pumps, high pressure cut-out, low pressure cut-out, oil pressure cut-out, built-in automatic capacity control etc.

One (1) No. shell and tube type water cooled condenser made of tested quality steel plate shell and integrally finned copper tubes complete with hot gas inlet, liquid outlet, relief and purge connection for refrigerant and water inlet, water outlet, drain connection etc.

One (1) No. shell and tube type water chiller made of tested quality steel plate shell and seamless copper tubes, plain from outside, integrally surface enhanced complete with liquid inlet and vapour outlet connection for refrigerant and water inlet, water outlet, drain connection etc.

Condenser shall be tested as per ARI Std. 550/590.

The minimum COP and IPLV of Screw/scroll type water chiller shall be 5.40 and 6.17 respectively as per ARI 550.

The IKW/TR of screw chillers shall not be more than 0.7 at 100%.

7.1.2 Accessories (valves, pressure gauges, water flow switches, controls and instruments etc shall be provided with each screw chiller as per customer approved PID.

7.1.3 Refer to clause 12.7.7 of section C-2, and other relevant clauses of section C-2, customer specifications.

7.2 CHILLED AND CONDENSER WATER PUMP SETS

7.2.1 Each Chilled water circulating pump set shall comprise of the following:-

One No horizontal split casing centrifugal pump of adequate capacity to match the package chiller/system requirement.

One No. adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply.

One set of base plate, coupling guard, anti-vibration pads, and foundation bolts etc.

Valves, Instruments other fittings etc along with chilled water pumps.

One No. Y-type strainer at inlet complete with brass screen, drain arrangement, etc.

150 mm dia dial type pressure gauges one each at suction & discharge side of the pump set.

Gate valves, one each at suction and discharge side of the pump set.

One No. non-return (check) valve at discharge side of pump set.

One No. Pressure Switch at discharge side of pump set

7.2.2 Pumps flow shall be selected as under:-

i) For condenser water pump @ 1.08 CMH/TR

ii) For chilled water pump @ 0.84 CMH/TR

7.2.3 Accessories (valves, pressure gauges, water flow switches, controls and instruments etc) shall be provided with pump as per customer approved PID.

7.2.4 Refer to clause 12.7.19 of section C-2 and other relevant clauses of section C-2, customer specifications.

7.3 COOLING TOWER

Induced draft fibre glass reinforced plastic (FRP) construction Cooling Towers, each CT complete with all accessories i.e. fan, motor (VFD driven), FRP basin, nozzles, level switch, make up connection, drains, piping, valves & fittings, strainer of brass wire mesh, ladder and supporting structure etc.

Cooling tower shall be designed as under:-

Design wet bulb: 28^0 C

Approach: 4^0 C

Refer to clause 12.07.11 and other relevant clauses of section C-2, customer specifications.

7.4 AIR HANDLING UNIT (DOUBLE SKIN TYPE)

Each air-handling unit shall comprise of the following: -

The casing of AHU shall be of double skin construction. Double skin sandwich panels (inside and outside) shall be fabricated using minimum 0.63 mm (24G) galvanised steel, with 25 mm thick polyurethane foam insulation of minimum 38 kg/m3 density in between 16G galvanised steel sheet channel shall be used as reinforcing to give structural strength (steel fame with vibration isolator of minimum efficiency of 85%).

Fan section complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.

One No adequately sized TEFC sq. cage induction motor suitable for 415 V, 3 phase, 50 Hz AC supply with drive package comprising fan pulley, motor pulley, V-belt and belt guard.

Cooling coil section (integral with filter section) with suitably sized chilled water cooling coil made of copper tubes and aluminium fins along with valves for isolation.

Fine filter and Hepa filter (At the discharge of each individual AHU) shall be provided for main control room control equipment room, battery charger room of main plant building only.

Drain piping from the AHUs up to nearest drain point.

Controls comprising

- One No. 3 way mixing valve with actuator
- One No. Proportionating type thermostat / temperature & RH sensor.

Serrated rubber pads for vibration isolation

Motors shall be installed inside the AHU.

Accessories (valves, pressure gauges, water flow switches, controls and instruments etc shall be provided with pump as per customer approved PID.

Refer to clause 12.7.10, 12.7.25 of section C-2 and other relevant clauses of section C-2, customer specifications.

7.5 STRIP HEATER PACKAGE AND HUMIDIFICATION PACKAGE

One common set of electrical strip heaters package of suitable capacity complete with contactor, air-stat, humidistat (room or mounted on strip heater control box), safety thermostat, heater box with insulation etc. for winter heating and monsoon reheat, mounted inside the AC plenum/duct for each AHU Room.

Heater package shall be connected with thermostat / Humidistat which will be provided in return air path inside AHU Room / Package AC Room.

Temp gauge, temp element shall also be provided and the same shall be hooked with PLC system. RH and temp sensor shall be provided and the same shall be hooked with PLC system.

One No. Pan humidification system comprising heater, humidistat, water tank, low level switch over flow, draining, make up connection, float valves etc for each AHU Room.

Refer to clause 12.7.24 and other relevant clause of section C-2, customer specifications.

7.6 SHEET METAL WORK

GSS supply and return air Ducting (as per IS-277) with 275 g/sqm of zinc coating complete with vanes, damper, hangers / supports etc.\Insulation of supply air AC duct and return air duct shall be provided as under:

S.No	Surface	Insulation Material	Insulation Form	Thickness (mm)	Finish
i)	AC Duct	Al foil faced PUF (density 48 Kg/m^3)	Roll / Slab	50	
ii)	Acoustic insulation of first 6M of ducting after AHUs but limited to plenum	Resin bonded fiberglass (density 48 Kg/m^3)	Board	50	30 G perforated Al sheet
iii)	Chilled water piping, valves & specialties (Indoor)	PUF (density 48 Kg/m^3)	Pipe Section	30	26 G Al sheet cladding
iv)	Chilled water piping, valves & specialties (Outdoor)	PUF (density 48 Kg/m^3)	Pipe Section	30	Sand cement plaster
v)	Expansion tank with pipe	PUF (density 48 Kg/m^3)	Slabs	50	

Motorized fire damper shall be installed at supply and return air duct at suitable locations where duct pass through wall & floors for ease of isolation, maintenance and as well as for emergency operation. Fire damper in the supply and return air duct shall close on receiving fire signal from fire protection system and shall also be possible manually from remote control panel. Necessary arrangement shall be incorporated in the duct for providing duct mounted multi- sensor detectors in the return air duct

for all air conditioned areas. Also respective Air Handling Units, Air washers/UAFs shall trip on receiving fire signal from fire protection system.

Diffusers, Grills & Dampers

- Supply air diffusers/grills with volume control dampers be provided for all air conditioned areas.
- Return air diffusers of air conditioned areas shall be without volume control dampers.
- The diffusers/grills shall be of extruded Aluminium of minimum 1.2 mm thick with powder coating.
- Supply air grills shall be of double deflection type and return air grills shall be of single deflection type.
- All volume control (VC) damper shall be operated by a key from the front of the grills/diffusers and shall be of GI sheet.
- The thickness of VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 22 gauge.
- Suitable vanes shall be provided in the duct collar to have uniform and proper air distribution. Bank of Baffles wherever required shall also be provided.
- Fire dampers shall be motor operated type and shall have fire rating of minimum 90 minutes.
- All plenum chambers of connections to fans, dampers etc shall be constructed in 18 gauge GS sheet and supported on MS angle frames
- All ducting surfaces coming in contact with corrosive fumes or gases shall be painted with three coats of epoxy paint over a coat of suitable primer.

Refer to clause 12.7.12, 13, 21, 22, 23, 27 of section C-2 and other relevant clauses of section C2, customer specifications.

7.7 INSULATION

Refer to clause 12.7.12, 12.7.13 and other relevant clauses of section C-2, customer specifications.

7.8 PIPING VALVES ETC

7.8.1 Piping

Condenser water piping

Condenser water piping interconnecting condensers, cooling tower, pumps etc. complete with strainers, valves, fittings etc. Black steel pipe conforming to IS-1239, upto 150 NB, Part I, heavy grade or IS-3589 (6mm thk), 200 NB and above depending upon pipe size shall be used.

Chilled water piping

- Chilled water piping with insulation interconnecting chiller, air-handling units and pumps sets complete with valves and fittings such as elbows, tees, reducers, flanges etc. Black steel pipe conforming to IS-1239, upto 150 NB part I, heavy grade or IS-3589 (min. 6mm thk), 200 NB and above depending upon pipe size shall be used.
- One No. HDPE / MS chilled water expansion tank complete with valve, Level Gauge, Level Switch, Make-up connection, overflow and drain etc.

Drain water piping

Drain water piping out of MS pipes conforming to IS-1239, Part I, heavy grade and galvanised as per IS:4736, from various equipments like chillers, pumps, AHUs, cooling tower area etc. up to the nearest drain point. (Within the room & for Cooling tower up to nearest drain point or rain water pipe on the roof)

Detail	Description
Piping for Chilled and Condenser water lines	Heavy grade-IS:1239 or Equivalent upto150 NB and IS:3589 or Equivalent for pipes beyond 200 NB
Drain piping	Same as above & galvanized as per IS:4736
Fittings	1. The steel fittings shall conform to ASTM A234 Gr. WPB and dimensional standard to ANSI B 16.9/ANSI B16.11 / equivalent for sizes 65 NB and above. 2. For sizes 50 NB and below, the material shall conform to ASTM A-105. 3. All steel flanges shall be of slip on type and shall conform to ANSI B 16.5 4. For pipe sizes above 350 NB, fabricated fittings from sheets of adequate thickness may be used. The bend radius in case of mitre bends shall be minimum 1.5 times the nominal pipe diameter and angle between two adjacent sections shall not be more than 22.5 deg and shall be as per BS:2633/BS:534. 5. Fittings, flanges and pipe joints of refrigerant piping shall conform to ANSIB31.5

7.8.2 Valve

- Valves shall have full sizes port and suitable for horizontal and as well as vertical installation. Valves for regulating duty shall be of globe type suitable for controlling throughout its lift.
- Gate, Globe and stop check valves shall have bonnet back seat to facilitate easy replacement of packing with the valves in service.
- All safety /relief valves shall be so constructed that the failure of any part does not obstruct the free discharge.
- Manual gear operators be provided for valves of size 250 NB and above.
- All valves with rising stem shall have position indicators. All valves shall be provided with locking arrangement.
- All water line valves shall be of Cast Iron body for sizes 65 NB and above conforming to IS: 14846 and Gun Metal construction for sizes less than 65NB conforming to IS:778. Cast Iron parts shall conform to IS:210 Gr. FG 220. However, butterfly valves shall confirm to latest revision of BS:5155 or equivalent standard of required class/rating.

7.8.3 Make up water tank

Make up water tank made of MS (with inner surface spray galvanised.) complete with valves, level gauge, level switch, make up connection, over flow and drain etc.

7.8.4 Refer to clause 12.7.28 and other relevant clauses of section C-2, customer specifications specifications.

7.9 Water softening plant

Water softening plant with 2X100 % configuration, to supply soft water for AC plant, shall be provided. Input water for softening plant shall be as per clarified water analysis available in the contract.

7.10 FRESH AIR FAN

1x100% Duty fresh air fan with pre-filter & fine filter in all AHU Rooms.

7.11 AIR FILTER

7.11.1 Pre Filter

a) Fabric Type

Filter medium shall be suitable fibrous material (e.g. choir, extruded sections of polyethylene, etc.) packaged into a frame of galvanized sheet steel of 20 gauge thickness. Filter element shall be felt filter fabric of suitable material recommended by the manufacturer. The filter shall be capable of being cleaned of the accumulated dust by tap water flushing. V-fold galvanized wire mesh interspaced with a flat layer of galvanized wire mesh for Metallic type pre-filters.

b) Metallic Panel Type

Filter medium, aluminium alloy shall be supported on galvanized expanded metal casing. Frame shall be fabricated from aluminium alloy of minimum 16 gauge thickness conforming to IS:737 or 18 gauge.

c) Efficiency

Average arrestance of 65 - 80 % when tested in accordance with BS:6540/ASHRAE – 52 – 76.

d) Minimum thickness : 50 mm

e) Face Velocity : Not more than 2.5 m/sec.

f) Pressure drop at rated flow : Initial pressure drop Less than 5 mmwc
: Final pressure drop Upto 7.5 mmwc

7.11.2 Fine Filters (Microvee type)

Construction: -	By pleating a continuous sheet of filter medium into closely spaced plates separated by heavy corrugated aluminium spacers.
Frame: -	Aluminium alloy of (minimum 16 gauge conforming to IS:737) with handles.
Other requirements: -	a) A neoprene sponge rubber sealing shall be provided on either face of the filter frame. b) Capable of being cleaned by air or water flushing
Efficiency: -	Average arrestance of 80-90% when tested in accordance with BS:6540/ASHRAE–52-76.
Minimum thickness: -	150 mm or 300 mm.
Face Velocity: -	Not more than 1.2 m/sec for 150 mm and not more than 2.4 m/sec. for 300 mm.
Pressure drop: -	Initial pressure drop - Not to exceed 10 mm WC at rated flow ; Final pressure drop-Up to 25 mm WC
Location	i) At the discharge of each individual AHU. ii) At the discharge of each Fresh air

7.11.3 Absolute Filter / Hepa Filter

Media: -	100% sub-microscopic glass fibers
Frame: -	Aluminium alloy of (minimum 16 gauge conforming to IS: 737) with handles
Other requirements: -	A neoprene sponge rubber sealing shall be provided on either face of the filter frame
Efficiency: -	99.97 % down to 0.3 micron when tested in accordance with BS:3928 (Sodium flame test)/FED–209B.
Minimum thickness: -	300 mm
Face Velocity: -	Not more than 1.2 m/sec.

Pressure drop: - Initial pressure drop - Not to exceed 25 mm WC at rated flow
Final pressure drop – Up to 75 mm WC.

Location: - At the discharge of each individual AHUs feeding to Common control room, control equipment rooms, battery charger rooms and SWAS room of main plant building.

8. CONTROL PHILOSPHY

A common PLC (shall be in TG package AC system supplier scope) based control system shall be provided for AC & Ventilation system. The PLC based control system shall cover the followings:-

AC system for main power house.

AC system for ESP bui lding.

AC system for service bld.

Air washer & UAF unit.

The operation of the AC Plant & the associated AHUs shall be done from the PLC based control panel located in the AC plant room. Control panels will incorporate start-stop push button lockable at stop position, controls & interlocks. The AC Plant compressor can be started only when its associated cooling tower fan, condenser & chilled water pumps are in operation. Standby selection of drives shall be done through Selection Switch to be located at control panel.

Chiller Package is to be provided with skid mounted microprocessor based control panel.

The operation of the packaged air conditioners and split window air conditioners with remote shall be done from local start –stop push button.

8.1 SAFETY CONTROLS

All necessary measuring – control instruments & control system shall be provided. With following compressor & evaporator interlock in the control panel of the Chiller Package.

a) High discharge pressure cut-out (HP)

b) Low suction pressure cut out (LP)

c) Oil pressure cut-out (OP)

d) Chilled and condenser water flow switch

e) Anti-freeze thermostat (AFT)

f) Airstat / safety thermostat with heaters of the AHU's

g) Crank case heater for compressors

h) Overload trip of cooling tower fan motor

8.2 OPERATING CONTROL

All operating control as necessary shall be provided. However following minimum control shall be provided. Central chilled water system shall have the following controls:

a) Automatic capacity control system.

b) Automatic unloaded starting device

c) Operating Thermostat

d) Unloading solenoid valves (if applicable)

e) 3 way flow control valve at the AHU's

f) AHU fan motor shall be provided with overload trip.

g) Strip heaters shall be provided with high Temperature and "no air flow cutout"

h) Humidity & Temperature indicator/sensor in control equipment room for monitoring shall be provided and the system will be hooked up with D.C.S

i) Operation / Sequence Interlock of the Air conditioning system shall be as under:

1. Cooling tower fan is started
2. The Air Handling Unit is started.
3. Chiller Pump is started
4. Chilling unit is started

8.3 INTERFACE WITH DCS

Following hardwired signals shall be provided in the DCS for monitoring purpose

a) Temperature & Humidity.

b) AC Plant On / Off Status.

c) Pump Run / Trip.

d) AHU Run / Trip.

e) General AC Plant Warning.

f) The operation of the air conditioners shall be done from local start–stop push button. Peripherals serial link shall be provided for the transfer of important signals to DCS in the central control room.

9. SPECIFIC REQUIREMENT

- Efficiency of centrifugal fan and pump shall not be less than 70%.
- Motor shall be designed for operation at 50^0 C temperature.
- Noise level generated by the equipment supplied shall not exceed the permissible limit of 65 dB (A) within the air conditioned served premises. In the air conditioning and ventilation plant room maximum allowable noise level shall be 85 dB (A) at a distance of 1 m from equipment.
- Electrical feeder suitable for following motor rating shall be provided for following equipment. Vendor to ensure that motor rating is not more than the rating mentioned below.

Sr. no.	Items	Motor rating (Kw)
1.	Screw Chiller	60
2.	Chilled Water Pump	11
3.	Condenser Water Pump	9.3

4.	AHU for ESP control bld unit-1	13
5.	AHU for ESP control bld unit-2	13
6.	Cooling Tower	7.5
7.	Fresh Air Fan	0.37

10.0 GENERAL

1) Basis of design all calculations including heat load calculations for summer seasons, equipment selection criterion, layout drawings/ schemes/G.A. dwg and documents like data sheet/ technical particulars etc are subject to Customer approval during detail engineering stage.

2) Vendor to furnish characteristic curves for all major equipment offered indicating duty point during detailed engineering.

3) All drawings and documents shall be computer based.

4) All commissioning spares & consumables for trouble free operation shall be provided Vendor to include level gauge & level switch for each tank for alarm & trip of the pumps. Also include one no. Pressure switch for each pump

5) Quality Requirements in the Technical Specification are indicating minimum requirements for inspection and testing. Vendor shall note that quality plan is subject to Customer & BHEL-approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

6) Indicative list of makes is enclosed as per Annexure-I however these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.

7) Inserts or any support arrangement for fixing ducting, fans, piping etc. shall not be provided by BHEL. Necessary supports may be taken from nearest structure / walls / roofs / floors etc. by Vendor.

8) Fixing frame works for diffusers and grilles in the scope of Vendor.

9) Anchor fastener shall be used by vendor for fixing duct pipes etc. wherever applicable.

10) Necessary supports and structures / frames etc. as required for supporting the duct / piping / equipments etc. as lump-sum basis is in the scope of Vendor and no unit rates shall be applicable for these items.

11) Drain piping within room up to the drain point to be provided by the Vendor.

12) Vendor to furnish schedule of power and control cables. Vendor to furnish cable termination details interconnection drawings etc. during detail engineering stage.

13) The tools and machine required for erection of equipment shall be arranged by Vendor.

14) Tools & tackles as required for regular maintenance shall be supplied by Vendor.

15) Instruments required for performance testing of various equipment / system of the package shall be arranged by Vendor at site.

16) Instrument for testing shall be calibrated by Air-conditioning plant supplier before taking up testing.

17) Temperature gauges shall be provided with thermo wells and fixing arrangement.

18) Pressure gauges shall have provision for air venting. Three way valves shall be used which shall have air venting provision.

19) Matching sockets / stubs (weld type) for flow switches and other instruments shall be supplied.

20) Bidders shall guarantee to maintain specified inside design conditions during summer, monsoon and winter and also even if the internal equipment load varies from 100% to 25%.

21) Besides the system performance as above, bidder shall guarantee major technical parameters of various equipments as per design basis / details furnished.

22) The guarantee tests shall cover but not limited to the following rated parameters for smooth operation of ventilation system.

- Design dry bulb temperature and relative humidity of conditioned air, Auxiliary power consumption, Vibration and noise level etc.
- Performance test of the Ventilation system shall be carried out at site after proper installation. The site test shall include performance testing of equipment for 72 continuous hours in summer or monsoon and 24 continuous hours in winter. Bidder, as may be required to carry out site tests shall arrange all instruments, tools etc.
- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder. Any Electrical/C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provide free of cost which are categorically listed in the Electrical scope sheet of technical specification.

23) For motorized fire damper / 3 Way valve actuators / motorised valves, power supply shall be derived by vendor from respective control panels. BHEL shall not provide any feeder for them. Suitable transformer shall be provided by bidder (if required) to derive the power input. Further distribution through junction box / distribution board shall be in vendor scope and shall have provision for isolation of individual fire damper/ valves.

24) Tender drawings enclosed form the part of specification and the bidder shall check the space requirements for installing the equipment as per the specification and layout requirements given in the specifications.

25) Bidder should suitably group the signals coming from various instruments etc. & the same shall terminate in local JB, from Local JB common cable to PLC / panel / MCC shall be selected. Any Electrical / C&I items and accessories like junction box, glands etc. shall be included by vendor in his scope. Only those items shall be provided free of cost which are categorically listed in the Electrical scope sheet of technical specification.

26) In the event of any conflict between the requirements of two clauses of this specification documents or requirements of different codes and standards specified, the more stringent requirement as per the interpretation of the owner shall apply.

27) Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Bidder to ensure proper net connectivity at their end.

28) Quality requirements in the Technical specification are minimum requirements for inspection and testing. Vendor to note that quality plans are subject to Customer approval during detail engineering stage. Standard QP format is enclosed in the technical specification.

29) 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 any number of time as per the requirement for across the table discussions/ finalizations/ submissions of drawings.

30) Sealing of duct opening, grouting of foundation / foundation bolts etc. including special type of grouting like GPX2 etc. are in the scope of Air-conditioning system vendor.

31) Flat, platform type RCC / PCC foundation shall be provided for installing Chiller/ PUMP, AHU and FAN etc. Vendor shall fix the equipment using anchor fasteners to secure the equipment obtain parameters related to vibration and noise.

32) Bidder to note that the P&ID shows only the bare minimum requirement of valves and instruments. Any instrumentation & valves as required for the completion of the system in line with technical specification shall be provided by bidder during detailed engineering without any commercial implication.

33) RCC foundation of cooling tower shall be provided by BHEL. However, steel beam / joist etc as required shall be supplied by air-conditioning plant supplier.

34) Air-conditioning plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

35) Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.

36) All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information / synopsis / specifications enclosed.

37) The bidder's proposal shall be for equipment in accordance with the tech. Specification.

38) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification.

39) Necessary duct mounted Booster fan (if required) to maintain the static pressure for Precision AC shall be provided without any implication.

40) All the instrumentation required for hook up with PLC panels (PLC panels are under scope of AC system supplier for TG Package) shall be in vendor's scope. The cables between instruments and PLC panels shall be supplied by BHEL (refer to electrical scope split) and the cable laying shall be in TG package AC system vendor's scope. However termination at the equipment / instrument end shall be in the scope of vendor for this package.

11.0 EXCLUSIONS

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

1. Construction of AC plant room, air handling unit room, foundations for AC equipments.
2. False ceiling, drop ceiling.
3. Slab cut out for running ducts, pipes, cables, grilles/dampers. Underground masonry trenches and masonry risers. However minor civil work like making opening to suit / finishing of opening, sealing of duct opening, grouting of foundation bolts including special type of grouting like GPX2 etc. are in the scope of AC system vendor.
4. Provision of drain traps / points,

5. For Electrical scope, refer Electrical scope matrix sheet.

12.0 Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall unless otherwise specified conform to the latest edition of the standards and codes including all addenda mentioned below:

IS-659 : Safety code for air-conditioning

IS-660 : Safety code for mechanical refrigeration

ASHRAE-23 : Standard method of testing and rating [67 Standards] air conditioner.

ARI-450-6 : Standards for water cooled refrigerant Condenser.

ASME Sec. VII : Unfired pressure vessels

IS-4503 : Shell and tube type heat exchanger.

ASHRAE 22-72 : Method of testing for rating water cooled refrigerant condenser.

ASHRAE-15-2007 : Safe Standard for Refrigeration System

ASHRAE-30-1995 : Method of testing liquid chilling packages

ANSI-8-31.5 : Refrigeration piping.

ANSI-8-9.1 : Safety code for mechanical refrigeration.

AR1-410 : Standard for air cooling and air heating coils.

AR1-210 : Standard for unitary air conditioning equipment.

IS-3588 : Specification for electrical axial flow fans.

AMCA-210 : Methods of performance test for fans.

BS-2831 : Methods of test for air filters used in AC and general ventilation.

IS-4671 : Expanded polystyrene for thermal insulation purpose.

IS-702 : Industrial bitumen

IS-1239 : Heavy class Pipes for sizes up to 150 mm dia.

IS-8188 : For Water conditioning

IS-325 : 3 phase induction motors

IS-4029 : Guide line for testing 3 phase induction motor

IS-210 : Specification grey iron casting

IS-2062 : Structural steel

AMCA - Bulletin : Standard code of testing centrifugal and axial No. 210 flow fans

IS-2825 : Code of practice for welding mild steel

IS-2676 : Dimensions for wrought aluminium and aluminium alloy sheets and strips.

ASHRAE Code : For various filter

ASHRAE-62-2004 : Ventilation rates

IS-655 : Specification for metal air ducts

PUMP DESIGN AND TESTING SHOULD CORRESPOND TO THE PROCEDURE MENTIONED IN IS-1520

SECTION: C 2

CUSTOMER SPECIFICATIONS

SECTION: C 2A

CUSTOMER SPECIFICATIONS
TECHNICAL REQUIREMENT

VOLUME – II A

SECTION – XII

AC & VENTILATION SYSTEM

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12.1 General

Ventilation and air conditioning facilities will be provided for the various plant premises to ensure proper working environment both for men and machine and to maintain necessary environmental conditions for proper storage of plant, equipment and materials.

This specification will be read in conjunction with other parts / volumes (Vol. I, , II, , III, IV, V, VI & VII of the NTA1-SG portion) of the specification where other related project requirements have been given.

The intent of specification is to cover provision of ventilation and air conditioning facilities including all accessories for steam generator package on turnkey basis for 2 x 500 MW power plant at Neyveli Tamilnadu, India, as per the detailed scope of work described in clause 12.3.

12.2 Codes & Standards

All equipment, systems and works covered under this specification will comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed and the following publications, norms / guidelines, standards, acts and rules.

- Publications of Bureau of Indian Standards (BIS).
- American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
- American Conference of Governmental Industrial Hygienists (ACGIH) publications, U.S.A.
- American Refrigeration Industries (ARI).
- Publications of International Standards Organisation (ISO).
- VDI stipulation for vibration level.
- Handbook of Air Conditioning System Design by 'Carrier Air Conditioning Company'

The following codes & standard will be followed:

- IS: 226 Specification for structural steel (standard quality)
- IS: 655 Specification for metal air duct.
- IS : 277 Specification for galvanised steel sheets
- SMACNA Sheet Metal and Air Conditioning Contractors National Association

The list furnished for standards and norms may not cover certain aspects or products. In such cases, where norms / standards / guidelines other than those listed above are followed, the contractor will furnish a copy of such document (s) in support for the purchaser's perusal and acceptance of this project. Whenever a contradiction is found between the different documents being followed the decision of the purchaser will be final and binding.

Metric system of units will be followed in design, manufacture and supply of all units. Name plates of equipment as well as operating / maintenance instructions will be in English language.

Noise level generated by the equipment supplied will not exceed the permissible limit of 65 dB (A) within the air conditioned served premises. In the air conditioning and ventilation plant room maximum allowable noise level will be 85 dB (A) at a distance of 1m from equipment.

The Contractor will also provide air conditioning and ventilation facilities to any other areas / technological system if envisaged besides those mentioned in this specification by the Contractor this stage or during detail engineering.

The air conditioning and ventilation equipment will be heavy duty type suitable for continuous operation under industrial duty conditions throughout the year.

12.3 Detailed Scope of Work

The scope of work covers the complete equipment / system design, engineering, manufacture / procurement, assembly, shop testing, shop painting, packing, transportation to site, unloading & storage at site, erection, supervision, site painting, testing, commissioning and conducting performance guarantee tests of all the ventilation & air conditioning systems including ducting, piping, dampers, valves, insulation, supports, measuring & control instruments etc.

The service facilities like civil, structural, electrics, illumination, instrumentation, water supply & drainage and handling & hoisting facilities needed for the ventilation and air conditioning systems will be included in the Contractor's scope of work.

Providing first charge of consumables like oil, grease, refrigerant etc. as required till successful completion of trial operation. The quantity and specification of such consumables will be indicated.

Supply of commissioning spares as may be required during erection, start up and initial operation of all the units / systems till successful completion of commissioning. The price for the commissioning spares will be deemed to be included in the contract price for the system.

Supply of tools & tackles required for maintenance of air conditioning and ventilation systems.

12.4 Performance Requirement

All equipment will be designed / selected such that the duty requirements as indicated in this specification can be maintained.

12.5 Inside design conditions

The following inside design conditions will be maintained in the various premises.

Sl.No	Premises	Inside dry bulb temp. °C	Relative Humidity %
1.	ESP Control rooms which also houses variable frequency drive panels of ID fans and other rooms need air conditioning	23 ± 1°C	55 ± 5%
2.	Central emission monitoring system room (CEMS), thyristor room(if applicable) for coal feeder drives	25°C (Max.)	-
3.	Shift In-charge rooms in ESP control room building, elevator machine rooms.	25°C (Max.)	
4.	MCC / Switch gear room, Electrical room, cable gallery and other rooms need supply air ventilation system	3°C above ambient temperature with pressurisation 2 – 3 mmWC	
5.	Fuel oil pump house, air compressor room, bunker bay building, AC plant rooms, chemical feed station, stores and toilets	Exhaust / general air exchange ventilation	

12.6 Design Criteria

The selection / design and manufacture of plant and equipment will be suitable for the intended service and the atmospheric / environmental conditions prevailing at the plant site.

The air conditioning and ventilation systems will include fan, dry panel type air filter, air conditioning unit, duct work, air supply grills, return air grills, dampers, insulation, piping, electrics, instrumentation and controls etc.

The following air velocities will be considered for the ventilation and air conditioning systems. However, standard sizes of equipment and accessories will be adopted satisfying the following limiting conditions.

- Louvers for air inlet - 1.5m/sec (max.)
- Dry panel filter (Face velocity) - 2.0 m/sec (max.)
- Main ducts (Ventilation) - 8 – 10 m/sec
- Main ducts (Air conditioning) - 6 – 8 m/sec

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- Branch duct (Ventilation) - 6 – 8 m/sec
- Branch duct (air conditioning) - 4 – 6 m/sec
- Air supply grills - 3 – 4 m/sec
- Return air grills - 2 – 3 m/sec
- Centrifugal fan at inlet/outlet - 8 – 10 m/sec
- Water velocity in piping - 1.5m/sec. (max.)

Air conditioning and ventilation equipment will be located in a separate plant rooms. The plant rooms will be provided with separate approach, fire fighting and handling & hoisting facilities by the Contractor. The equipment will have at least 10% reserve capacity. Design calculations will be submitted for selection of system capacity as well as equipment selection. Air conditioning and ventilation systems will be designed considering the fire safety norms and will be interlocked with the fire detection system of the plant.

Central air conditioning system with chilled water based (vapor compression type) will be provided for ESP control rooms which also houses variable frequency drive panels of ID fans, Shift in charge rooms and other rooms require air conditioning facilities. Under deck insulation will be provided for all exposed roofs in the air-conditioned premises.

Chilled water expansion cum make up tank of adequate capacity will be provided at the highest point in the chilled water circuit. The tank will be complete with all accessories like float valve, limit switch with level indicator quick fill, drain, over flow etc. The tank will be thermally insulated.

Window type room air conditioner / Split type air conditioner will be used for air conditioning of the rooms for CEMS, thyristor room (if applicable) for lignite feeder drives and other small rooms located in far away from chilled water plant.

MCC / switch gear room, electrical room, cable gallery and other rooms require fresh air ventilation will be provided with fresh filtered air supply system. The rooms will be pressurized to 2 – 3 mmWC to prevent dust ingress by providing wall mounted gravity dampers.

Fuel oil pump house, air compressor room, bunker bay building, elevator machine rooms, AC plant rooms, chemical feed station, stores, toilet and other rooms generating fumes / heat will be provided with pressurized ventilation exhaust ventilation by installing wall mounted axial flow fan.

12.7 Type and Rating Of Equipment

Equipment Selection Criteria

12.7.1 Air conditioning systems

Air conditioning systems for ESP control room buildings of steam generation unit-I and unit-II will be provided. Common AC plant (if applicable) for ESP control rooms of unit 1 & 2 with 2 nos. screw chillers (1 W + 1 SB). Common AC plant

will be located in ESP building of Unit – 1. The contractor will do the design calculation of their own and furnish to the Owner/Consultant for approval for finalization of the system.

Chilled Water Plant for Air Conditioning System

The chilled water plant (for each ESP control room building) will include

Common AC plant for ESP control room unit 1 & 2 with:

a) 2 nos. screw chillers (1 W + 1 SB)
b) Chilled water pumps, 2 Nos. (1W+1R)
c) Condenser water pumps, 2 Nos. (1W+1R)
d) AHUs with accessories, 3 Nos (2W+1R)
e) Fan coil units for shift in charge room, quantity as per requirement.
f) Cooling tower with accessories – 2 Nos (1W + 1S).
g) Chilled water and condenser water piping with valves, pressure gauge, strainer etc.
h) Flow components in pipe lines
i) Thermal insulation of chilled water pipelines.
j) Humidity control arrangement with strip heater and pan humidifier
k) Refrigerant piping, valves and fittings
l) Ducting network with damper, supply air diffuser, return air grills, acoustic and thermal insulation.
m) Make up air filter with damper in different AHU rooms.
n) Insulated expansion tank. Tank will be located at the top most location of the entire chilled water piping network.
o) MCC, starter panel, electrics, instrumentation & controls etc.

Vapor compression machine with screw chiller will be chosen not only to ensure chilled water supply but also to perform efficiently at lower loads and at lower condenser water inlet temperature (particularly during winter season). If needed condenser water temperature control will be provided.

In general effort will be made for connecting the return air path from the control rooms in the gap between the roof and false ceiling and led back to the AHUs. Necessary duct line thermal and acoustic insulation will be provided as required.

Contractor will furnish the capacity range & inlet condenser water temperature range for their machines.

The Vapor compression machine with screw chiller and all pump sets will be installed in the AC plant room and various AHUs in AHU rooms to be located near / adjacent to the served premises.

Central emission monitoring system room (CEMS) & small rooms far away from chilled water plant will be air conditioned by providing suitable Split / window type air conditioner.

The cooling capacity of air conditioning system will be decided on the basis of heat dissipated in the premises, building heat radiation, illumination heat, occupancy heat, make up air heat etc. in the premises. Fresh air quantity will be based on 1.5 air changes / hour. The system will have at least 10% reserve capacity.

The air conditioning system will be provided with heating coil & humidifier for winter heating & humidity control.

12.7.2 Ventilation systems

Unitary Air Filtration (UAF) Unit for SG area (If applicable)

Ventilation system for SG area (i.e MCC/Switch gear rooms, electrical rooms, cable gallery and other rooms need supply air ventilation system inside ESP control room building) with unitary air filtration type air washer system will be provided. Saturation efficiency will be 70 % minimum.

Each UAF will consist 1x100% Centrifugal fan, 2x100% centrifugal circulating water pumps, air intake louvers, filters, evaporative cooling spray nozzles (Brass/ gun metal), UAF internals, ducting & piping network and other accessories. Cable galleries will be provided with miltilouvred gravity dampers to have positive pressure and also prevent dust nuisance. With this system the dry bulb temperature within the building will be maintained at a temperature not exceeding ambient temperature. The UAF capacity is to be decided based on:
Total internal heat load within the building, inclusive of electrical bay and maintenance bay and considering the heat dissipated by various electrical switchgear, equipment hot surfaces, steam piping as well as the dissipated heat, solar transmission through the building wall and glass, and any other sources of heat.

- Air change per hour (ACPH) as per design basis requirement
- Saturation Efficiency of air-washer will be 70% with spray system.

12.7.3 UAF for SG Area Building- Design and constructional details

i) UAF unit complete with air louver, single bank spray header with Polypropylene nozzles spraying water on flooded type water repellent filters, moisture eliminator, inspection window, marine light, maintenance cutaway etc. Saturation efficiency of UAF unit will not be less than 70%.

ii) Centrifugal pumps (one running & one stand by) complete with drive motors and accessories such as suction screen, pot strainer with bypass line valves, bends and fittings, inlet / outlet pressure gauge with isolating cock, complete make-up water plumbing with float valve, quick fill connection internal fitting

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and supports, drain piping with valve, over flow connection, discharge piping etc will be provided.

iii) Piping for feed and make up water and also GI ducting grilles with volume control damper for UAF units will also be included.

iv) The sheet thickness for air washer tank will be 6mm and for the body of the air washer will be 5 mm.The casing and tank will be made of mild steel plate IS-2062 with epoxy protective paints inside and outside for corrosion protection. The distributor will be made of galvanised sheet steel and eliminators will be made of PVC.

v) The face velocity of air washer chamber will not be more than 2.5 m/sec.

12.7.4 Water Flooded Filter

i). The filter media will be of cleanable metallic type with efficiency 90% down to particle size of 10 microns when flooded with water.

ii). The filter media will be firmly secured on frame of rust proof material.

12.7.5 Moisture Eliminator Sets

i). Moisture eliminator sets used for the unitary air filtration units will be vertical and minimum 3 break type of PVC.

ii). Face velocity of air for the eliminator sets will not exceed 2.5 m/sec, Saturation efficiency of UAF ventilation system will not be less than 70 % for SG Area.

12.7.6 Design and Construction Details of Air Conditioning Systems

The equipment will be normally as per general specification of the project. However, brief description of main equipment is given below:

12.7.7 Vapor compression based Chiller

i) The packaged chilled water unit will be completely factory assembled and designed for continuous duty. Each package chiller unit will essentially comprise of rotary twin screw compressor, shell & tube type water chiller, refrigerant circuit, water cooled condenser, electric drives, instruments and controls and other standard accessories assembled in steel cabinet. The compressor will be semi-hermetically mounted on anti-vibration pads & dynamically balanced. Each chiller will have multiple screw compressors with independent refrigerant circuit.

ii) The chiller will be supplied with full operating charge of refrigerant R-134a & lubricating oil. Chiller performance will be ARI certified as per ARI standard 550. Cooler (evaporator) will be dry expansion type.

iii) Condenser will be shell & tube type construction dual refrigerant circuit water-cooled type. Unit will be equipped with suitable integral finned type, solid drawn, seamless copper tubes. The tubes will have internal turbulator. Fins will be made of Aluminium. Condenser shell will be constructed and tested in

accordance with section VIII, division I of ASME pressure vessel code. The shell will be capable to withstand refrigerant pressure of 300 psig, where as the tube side will be capable to withstand a water pressure of 150 psig. Cast iron water heads will be incorporated for easy removal, mechanical tube cleaning and/or tube replacement. Condenser will be provided with multiple pass to give optimum water velocity through tubes combining efficient heat transfer and allowable pressure drop.

iv) Fouling factor to be considered while designing the condenser will be 0.00025h-ft^2 F/Btu and temperature difference between inlet and outlet water will be approx. 7.5°F.

v) A special tube arrangement and the partition plate allow cooling water to pass through the condensed refrigerant and thereby sub-cooling the liquid. This produces higher refrigeration capacity without increasing the power consumption. Condenser will be tested as per ARI standard 550/590.

vi) Condenser will be provided with the following accessories / safety devices:

- Purge valve
- Charging valve
- Relief valve/ Fusible plug
- Liquid level indicator
- Flanged hot gas inlet / liquid outlet connection.
- Hand shut off valve for water inlet and outlet connection
- Flow switch in condenser water line
- Pressure & temperature gauges for water inlet and outlet
- Vent valve
- Drain valve

vii) Copper tubes of minimum diameter 16mm will be rolled in to grooves on tube sheet for a water tight and air tight joint. Joints between the tube sheet and the shell will be water tight while those between the shell and boxes will be airtight. Adequate sealing gaskets will be provided to prevent leakage of refrigerant and the infiltration of moisture and air in to the system Fouling Factor (water-side) 0.0001h-ft2F/Btu will be considered for design of cooler.

viii) Cooler shell will be capable of withstanding a pressure of 150 psig on shell side while 225 psig. on the tube side. Refrigerant will pass through the tube while water through the baffled shell. Refrigerant head is designed for proper number of passes to ensure refrigerant pressure drop is within the limit and adequate velocity for proper oil carry-over long with vapours.

ix) The chillier assembly will be thermally insulated with Armaflex material of 50mm thick and finished with aluminium cladding.

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x) Minimum superheat of 3o C under design condition will be considered while selecting the chillers.

Following controls and safety devices / accessories will be incorporated in the chillers.

- Cooling and Anti freeze thermostat
- Flanged water inlet and outlet connection with flanges and shut off valves, including industrial type thermometer.
- Relief valve, purge valve, drain valve
- Pressure and temperature gauges at the water inlet and outlet.
- Refrigerant charging connection in the valve
- Flow meter and switches on the water line.
- View port

12.7.8 Split type Air-Conditioner

Split air conditioning unit will mainly comprise of two sections, viz. Indoor and Outdoor section. Indoor section comprises of cooling coil, fan, filter and supply air grills. Outdoor section comprises of air cooled condenser, blower, hermetically sealed compressor. Sealed refrigerant piping interconnects the indoor and outdoor sections. Outdoor unit will be installed in open space for easy heat dissipation from condenser. Indoor section will be high ceiling suspended or wall mounted type as per requirement. Remote control unit, thermostat and other standard accessories for successful installation of split type air conditioner will be included in the scope of Contractor. Any additional services required will be included in line with requirement. Split air conditioner unit will conform to IS:1391-1992 Part II.

12.7.9 Window Air-Conditioner

Window type air conditioner will comprise of hermetically sealed compressor, air cooled condenser, refrigerant piping, fan, instruments and controls, supply air grills with direction deflectors etc. enclosed in an insulated steel cabinet. Provision will be made in the front panel of the unit for controlling room ventilation and fresh air supply. Air filter installed will be of HDPE easily cleanable type. The front panel will be suiting to the interior décor of the room.

12.7.10 Air Handling Unit

i) The Air handling unit (AHU) will comprise of the following sections. The AHU will be provided with suitable control, instrumentation and accessories including switch fuse unit.

(a). Filter section

(b). Coil section

(c). Damper section

(d). Blower section

(e). Heater section

ii) Air handling unit will be made of GI sheet and rigid angle iron frame. Removable panels with double skin and sand witched insulation will be provided to make internal parts easily accessible for service and inspection, polyurethane foam (puf) insulation will be provided to prevent heat transfer to colder sections.

iii) Filter section should comprise of two filter banks, one, for pre-filtration and other for fine filtration.

iv) Velocity of air will not exceed 2.5 m/sec for pre filter and 1.5 m/sec for fine filter. Fine filter elements will be of superior compressed fill with adequate wool quantity.

v) Recommended pressure drop across filters when they are completely loaded is 12 mm WC.

vi) Filter framework will have lifting handles and locking metal wedges. Filter frame will be fabricated from MS sheet of suitable thickness in welded construction. All leakage areas should be sealed with suitable sealing compound.

vii) Cleaning efficiency of pre and fine filter will be according to manufacturer standard practice. Filter panels will be cleanable and reusable type.

viii) Coil section will have cooling coil manufactured from solid drawn copper tube with mechanically bonded aluminium fins. Face velocity of coil will not exceed 2.5m /sec. and pressure drop across the coil will be as minimum as possible.

ix) Damper section will be face and bypass damper. Damper should be suitable for automatic operation actuated by modutrol motor and modulating thermostat. Damper should have proportioning louvers so arranged that when face damper closes, bypass damper opens. No external bypass of air is acceptable

x) Manual dampers at the outlet of all the AHUs of air conditioning system will be provided.

xi) Centrifugal fan will be limit load characteristics.

xii) Impeller and shaft assembly of fan will be statically and dynamically balanced.

xiii) Centrifugal fan will conform to IS: 4894. Fan and motor assembly will be mounted on a common vibration proof base frame and the assembly will be provided with vibration arrestors, at the commissioning stage the vibration amplitudes will be measured to ensure that the vibrations are within the permissible limit.

xiv) Critical speed of the fan will be minimum 125% of the operating speed.

xv) Fan outlet will be fitted with canvass connections to isolate the vibration and outlet damper for the control of capacity.

xvi) Fan for AHUs will be provided taking care of pressure drop in the prefilter, fine filter, ducting losses in coil and other losses if any.

xvii) For fresh air requirement to AHU of ESP cum VFD Control room and for other areas, fresh air arrangement comprising of sheet metal fresh air duct will be provided with goose neck connection at intakes so as to serve as rain protection cover and bird guard. Filter element to match duct size and louvered damper complete with operation linkage to suit manual operation is to be provided. Fresh air filter element will be similar to that specified for prefilter earlier in the specification.

xviii) Heater section will consist of bank of electrically operated strip heaters to provide monsoon reheating as required and also winter heating for total air quantity to maintain specified inside design conditions. Selection of strip heater should be such that face velocity across heater is maintained at 2 to 3 m/sec. Heater bank frame should be electrically insulated for human safety. Heater will be flame proof/spark proof/tubular construction. Heater will be interlocked with AHU fan.

12.7.11 Cooling Tower

Induced draft type FRP cooling towers (1W + 1S) will be provided for the cooling of condenser water for chilled water air conditioning system. The cooling tower will be provided with fan & motor. The motor of fan will be of weather proof construction.

Cooling tower will be designed, manufactured and performance tested as per CTI codes. The capacity of the cooling tower will be adequate to take care of the cooling water requirement for the chilled water air conditioning system. The cooling tower will be mounted on RCC pillars near the air conditioning plant room. Inside fills will be of PVC.

Cooling tower basin will have accessories and connections for makeup, quick fill, drain screens and over flow. Float valve and limit switch interlocked with solenoid valves will be provided in the makeup water. The water distribution system will be either open basin with gravity feed nozzles or pipe system with nozzles requiring not more than 0.42 kg/sq.cm. water pressure at rated capacity. The nozzles will be spaced to give even distribution of water. The system will be self-draining, non-clogging and designed for flexible operation and ready accessibility. Suitable measuring orifices will be provided. All main piping connections will be brought out and will end in flanges to facilitate connections.

All the fasteners will be of stainless steel. Rubber/Neoprene gaskets must be used on all bolted joints as a seal against water leakage.

Nozzles for cooling tower will be of brass/gunmetal/stainless steel/ suitable material conforming to applicable standards. The cooling tower will be complete with ladder for maintenance and service requirements.

12.7.12 Insulation

i. Acoustic insulation

Acoustic insulation will be provided in the supply air duct up to 3m from AHUs. For applying acoustic insulation inside duct hot bitumen/ cold adhesive will be provided at the clean inside surface of duct. Then 25mm thick mineral wool will be provided. To hold the insulation 30 SWG perforated aluminium sheet will be provided and riveted with duct. Perforation will be of 5mm and 8 to 10mm centre to centre distance.

12.7.13 Thermal insulation

Thermal insulation will be provided on a portion of supply air duct out side the conditioned premises, pan humidifier, chilled water piping, drain pipes connected with insulated equipment etc. Thermal insulation of tail end duct will be provided to avoid condensation of moisture on the outside surface of the duct. The return air duct outside conditioned premises will also be insulated.

For applying thermal insulation, the outside surface of the duct/ pipe should be cleaned first, then hot bitumen/ cold adhesive should be applied on the clean surface. Then 50mm thick insulation material (mineral wool mat) with wire netting on outside will be provided. Then polythene with 50mm overlap will be sealed with adhesive. The polythene will be covered with 26 SWG aluminium sheet. All joints will be locked with self locking screw at a pitch of min 100mm.

12.7.14 Instruments and Controls

Following will be provided as applicable.

a) HP / LP cut out switch
b) Cooling and Antifreeze Thermostat
c) Pressure gauge and temperature gauge (6" dial type) in condenser water line and chilled water line
d) Water flow switch with interlock
e) Chilled water supply and return line valves, by pass valve, pressure and temperature gauges at supply and return line, AHU end
f) Refrigerant and water line strainers
g) Condenser purge, charging & relief valve
h) Refrigerant compressor HP, LP, OP gauges
i) Non return valve at pump out let
j) Any other instruments required for the system

12.7.15 Make up Water Tank

Make up water tanks will be provided for cooling tower of air conditioning systems. Tanks will be MS & inner surface spray galvanised. Make up water line with float valve & backup ball valve, quick fill line with ball valve, drain line with ball valve, overflow & vent line, level gauge will be provided.

12.7.16 Centrifugal Fan

These are used for ventilation system. The fans will be of limit load design. The fan will be of rugged steel construction and suitable for industrial duty condition. Fan housing will be of welded construction and provided with flanges at inlet and outlet sides for duct connections. The housing will be provided with lifting eye for ease of handling and bolted type access door.

The fan unit will be reasonably noise and vibration free in operation. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A). The fan will be single inlet single width (SISW) type as per requirement. The fan will be both statically and dynamically balanced.

12.7.17 Dry Panel Filter

Dry panel type air filter will be of high efficiency cleanable type, constructed out of HDPE (6 ply) supported by layers of GI wire gauge. It will be corrugated to the depth of filter casing in order to increase the ratio of filtration area to frontal area. It will be covered by strong GI/MS frame and have space to ensure uniform distribution of air. Filtering panel will be of standard size which can be mounted on angle frame in multiple number as per capacity of the fan. Face velocity of air will not exceed 2 m/sec. The resistance of air filter will not exceed 10 mmWC when dirty. Efficiency of the filter will not be less than 90% down to 10 microns. The whole filter and frame assembly will be fixed in a sheet metal casing of not less than 3.15 mm thick M S sheet.

12.7.18 Axial Flow (Tube Axial) Fan

These fans will be of heavy duty type. Fan impeller blades will be of aerofoil section of cast aluminium alloy. The impeller will be directly mounted on the motor shaft and the assembly will be mounted inside rigid tubular casing. Cable termination provision will be made on tubular casing. The connecting flanges will be provided at both ends of tube. Tube casing will be of minimum 2.5 mm thick M S sheet. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A).

Axial Flow (Propeller) Fan

These are used for general ventilation of premises emitting heat / fumes. These will be of heavy duty and wall mounted type. Fan impeller blade will be aerofoil section and mounted directly on the motor shaft. Air entry from motor side. Louver shutter will be provided at the out let side of the fan to prevent back draft. Consequent loss in capacity will be taken in to account while selecting the fan. The noise level for fan and motor assembly at 1 meter distance will be limited to 85 dB (A).

Adjustable louver grills (Supply air Grills)

1.25mm MS sheet / 1mm GI sheet will be used for the manufacture of grill. All grills will be true to shape and will be checked with a level gauge before being secured in position. No distortion or warping is permitted.

Self Acting Damper (Gravity Damper)

Self acting dampers are provided to maintain pressurisation inside the premises. The damper will be of gravity type designed such as not to allow infiltration of air from out side. The damper will be multi blade type made of aluminium flaps of not less than 24G thickness and MS frame. These will be designed such that these will operate when the pressure inside the premises exceeds 2-3 mm WC. It can operate in fully open or partial open positions.

12.7.19 Centrifugal pump

The pumps will be designed, manufactured and tested as per IS: 1520-1980 (R.A. 1993), IS: 5120-1977 (R.A.1997) Amendment 2000, IS: 9137-1978 (R.A. 1993), IS6595-1993 (Part II) or as per other international standards acceptable to the Purchaser and will be suitable for the duty conditions and capacities as indicated in this specification.

The power rating of the pump motor will be larger of the following 110% of the power required at the duty point.

For parallel operation, motor rating should be sufficient enough for running of single pump also.

i. Shaft

The shaft will be of EN-8 or C-40 or equivalent and will be designed for critical speed. The ratio of critical speed to speed of shaft will be not less than 1.2 for solid shafts.

ii. Shaft sealing

Mechanical type Shaft seals will be provided to prevent leakage out of, or into, a pump over the range of specified operating conditions. The seals will be suitable for variations in inlet conditions that may prevail during start-up and shut down. They will be accessible for inspection and replacement without disturbing any part of the installation.

12.7.20 Bearing

Two bearing assemblies will be provided, one within the frame to carry radial load only and the other to carry both radial and axial thrust. Bearings will be of manufacturer standard design, antifriction type, oil / grease lubricated. Suitable thrust bearings will be provided in the pump to take total thrust of the pump including hydraulic thrust. Thrust bearings will be of oil lubricated type with suitable cooling arrangement. Motor thrust bearing will be designed without water cooling arrangement. Suitable tapped holes will be provided for refilling of oil in the bearing housing.

12.7.21 Duct Work

Ducting will be fabricated from GI sheet as per IS: 655 standards. The ducting will be properly reinforced and braced to prevent sagging, buckling or vibration.

However minimum thickness of GI sheet will be 1mm considering the industrial duty conditions.

Flanges of sheet metal duct will be of angle iron type riveted with GI sheet on duct perimeter. Flange joints should be made air tight with use of felt gaskets. Spacing of duct flanges will be about 3 meters.

Turning guide vanes are to be provided inside the duct wherever change of direction occurs, to minimise eddy formation. The interior of all ducts will be smooth for free flow of air. Bends / elbows wherever used in duct work will have radius not less than the depth of duct work in change of direction. Collar is to be provided to duct bottom to connect with throat of supply air diffuser.

Access eye / measuring hatch for measurement of air quantity will be provided in ducting at convenient location. Duct work will be complete with flanges, stiffeners, fasteners, hangers, nuts, bolts, washer & gaskets etc.

12.7.22 Supply Air Diffusers

Supply air diffusers will be square / rectangular / circular in shape. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the diffuser as well as for supply of air. No part of diffuser will project into the main duct. Each diffuser will be provided with volume control damper. Each diffuser will comprise of fixed plate, damper blade, damper blade operating knob, spindle, connecting rod etc and will be removable core type dully powder coated. The diffuser bottom should flush / match with the false ceiling. False ceiling will not bear the load of any diffuser. The load of any diffuser will be borne by the duct and collar. Each diffuser will be powder coated with appropriate colour to match with the colour of the false ceiling. The diffusers will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

12.7.23 Return Air Duct

The air supplied in the served premises will return above false ceiling through return air grills / the return air slit of 50mm / 75mm (as required) all around false ceiling along the walls of the served premises. From there it will pass into the AHU room through a return air duct. Insulated return air duct of suitable size will be provided for smooth flow of return air. The return air duct will be connected to the AHU so that the AHU room will not be conditioned and this will avoid the heat load of the AHU room. Return air opening will be provided above false ceiling in the partition wall between served premises and AHU room.

12.7.24 Strip Heater Box

Strip heater box will comprise of finned heater, mounting plate, heater box/ casing made of 20 SWG G.I. sheet, cable terminal, terminal box with handle, 40x40x3 MS angle flange/ frame. Strip heater box will be placed/ inserted in supply air duct. Safety thermostat will be mounted on strip heater package to prevent

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overheating. Strip heater box assembly will be a pre-fabricated unit with all its terminals and controls pre-wired.

12.7.25 Multi-louvre Damper

Multi-louvre damper will be provided at the out let of AHUs and below flexible connection in the supply air ducting. The damper blades/ louvres will be provided with external operating links for manual operation of the damper to control air flow. The damper will be made of GI sheet with MS frame. The fully close / open / partial closing position of the damper will be marked on the damper casing.

12.7.26 Thermometer and Pressure Gauge

Wet bulb and dry bulb thermometer will be provided and installed in the control room to measure the premises temperature.

Dial type (100 mm) mercury in steel thermometer will be provided for measuring the water temperature at inlet & outlet of condenser. The range of thermometer will be 0-100 °C.

Dial type (100 mm) pressure gauges will be provided at inlet as well at outlet of condenser water lines.

12.7.27 Return Air Grills

Return air grills will be square / rectangular / circular in shape. The throat of a diffuser will be connected with collar piece provided at the duct bottom for holding the grills. No part of grills will project into the return air duct. The bottom of grills should flush / match with the false ceiling. Each grills will be powder coated with appropriate colour to match with the colour of the false ceiling. The grills will be true to shape and will be checked with level gauge before being secured in position. No distortion or warping is permitted.

12.7.28 Condenser cooling water piping with accessories

Medium class GI piping is to be used as per IS: 1239 for interconnecting water piping network. Velocity of water in the pipe line will be limited to 1.5 m/sec. Butterfly valve will be provided in water pipeline for control and regulation purposes. Butterfly valve and non return valve will be provided in the delivery side of pumps.

Pot strainer will be provided in the water pipe line at inlet of condenser with by pass connection with isolation valves. Pipe fittings like bends, elbows, flanges, sockets, nipples etc. will be as per relevant IS/BS standards.

Drain piping network is to be included as required for condensate drain, with isolation valves at proper places. All piping will be tested to hydrostatic test pressure of at least one and half times the maximum operating pressure for period of not less than 24 hours. System may be tested in sections and such section will be securely capped.

12.7.29 Performance Parameters

The contractor will ensure the performance of ventilation and air conditioning systems on the following accounts:

- Ensuring specified capacities of various equipment
- Ensuring specified inside design conditions.
- The equipment will be statically & dynamically balanced.
- No overheating of bearings.
- No leakage in the ducting / piping system and equipment.
- Designed air flow at various points of system.

Performance testing and setting right of the equipment for the system will be carried out by the contractor at site.

12.7.30 Technical Data To Be Submitted

Contractor will furnish the following technical data for air conditioning and ventilation equipment / system during detail engineering and will ensure that such data/details will be in line with the requirements indicated in the Contract documents

Vapor Compression Machine	
1. Refrigerant Compressor a) Manufacturer b) Model No. c) Refrigerant d) Capacity at operating conditions with specific capacity of each type e) Maximum speed/operating speed f) BHP at operating conditions g) BHP/TR at operating conditions h) BHP consumption 100% load 75% load	DDE
2. Condenser a) Manufacturer b) Shell diameter and length (mm) c) Tube material d) Fouling factor e) No. of tubes	DDE
3. Water Chiller a) Manufacturer	DDE

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Vapor Compression Machine	
b) Shell diameter and length (mm) c) Tube material d) Fouling factor e) No. of tubes	
4. Air handling unit / fan coil unit. a) Make & Model No. with specific capacity of each type b) Type of unit (Horizontal/vertical) c) Overall dimensions (mm)	DDE
5. Fan Section a) Air quantity (m3/hr) with specific capacity of each type b) Total/static pressure (mmWC) c) Fan speed (RPM) d) Fan dia (mm) & number e) Balancing (Static and dynamic) f) Fan motor (kW)	DDE
6. Cooling coil a) Coil fin materials b) Tube dia (mm) and thicknes	DDE
7. Filter section Pre filter a) Type & make b) Gross filter area (m^2) c) Velocity through filter (m/sec) d) Pressure drop through filter when dirty & when clean (mmWC) e) Efficiency	DDE
8. Split Air Conditioners / Window Air Conditioners a) Make & Model b) Quantity c) Capacity in TR (Nominal / Actual)	DDE

Vapor Compression Machine	
d) Air Flow m^3/h	
9. Centrifugal Fan a. Fan i. Make & Model No. ii. Quantity, no. iii. Type of blade iv. Capacity, m^3/h v. Static and Total pressure, mm WC vi. Speed, rpm vii. Shaft power, kW viii. Total / Static Efficiency, % ix. Motor rating, kW/ pole	DDE
b. Fan Drive Motor i. Type & make ii. Voltage, phase & frequency iii. Rated power iv. Speed	DDE
c. Axial Flow Fan i. Make & Model ii. Capacity in m^3/h. iii. Total / Static Pressure, mm WC iv. Material of construction and its thickness v. Speed in rpm.	DDE
10. Centrifugal Pump Set i. Make and model no. with specific capacity of each type ii. Type of pump iii. Capacity in m^3/hr. iv. Total head in m WC v. Material of Construction of vi. Shaft	DDE

Vapor Compression Machine	
vii. Impeller viii. Casing ix. Pump speed (rpm) x. Shaft power xi. Drive details xii. Motor make xiii. Motor kW xiv. Class of insulation xv. Frame size	
11. Dry Panel Filter f) Make & Model. g) Capacity in m^3/h. h) Pressure drop in mmWC. i) When clean ii) When dirty i) Effective cross sectional area in m^2	DDE
12. Cooling tower a) Make & Model b) Type c) Quantity d) Overall size of cooling tower e) Capacity of cooling in TR. f) Water flow m^3/h	DDE

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SECTION: C 2B

CUSTOMER SPECIFICATIONS

GENERAL TECHNICAL REQUIREMENT
GENERAL TERMS & CONDITIONS OF CONTRACT,
SAFETY CODE FOR CONTRACTORS,
GENERAL CONDITIONS FOR ERECTION WORKS AND CIVIL WORKS
&
PERFORMANCE GUARANTEES

VOLUME-II A
SECTION - II
GENERAL TECHNICAL REQUIREMENTS

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2.1 Codes and Standards

1. Except where otherwise specified, the SG and its auxiliaries will comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Contractor will give all particulars and details as necessary.
2. Where the Contractor proposes alternative codes or standards he will include in his tender one copy (in English) of each Standard Specification to which materials offered will comply. In such case, the adopted alternative standard will be equivalent or superior to the standards mentioned in the specification.
3. Wherever specified or required the SG and its auxiliaries will conform to various statutory regulations including but not limited to Indian Boiler Regulations, Indian Electricity Rules, Indian Explosives Act, Factories Act etc. Wherever required, approval for the SG and its auxiliaries supplied under the specification from statutory authorities will be the responsibility of the Contractor.
4. In the event of any conflict between the codes and standards referred above and the requirements of this specification, the requirements which are more stringent will govern.
5. In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing the Owner/Consultant will have the option to incorporate the changed requirements. It will be the responsibility of the Contractor to advise Owner/Consultant of the resulting effect. Financial implications if any will be discussed mutually agreed and finalised.

2.2 Responsibility for Design

1. The Contractor will take full responsibility for the design of the whole and every portion of the SG , whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work.
2. Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed will have been adequately developed and will have demonstrated their performance adequately under similar site conditions.
3. The Contractor will have to carry out transient condition studies as may be necessary and as required by the Owner/Consultant as per good industry practice.
4. The Contractor may choose to include a detailed discussion on the development status and the reasons for any changes made in proposed systems or components for the SG, as compared with similar items previously supplied in other installations cited by the Contractor as reference plants. In that event the Contractor will substantiate such changes without changing the functional capability of the SG.

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2.3 Name Plates (Rating Plates)

1. Instruction plates, nameplates or labels will be permanently attached to each main and auxiliary item of SG in a conspicuous position. These plates will be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of SG has been designed to operate.
2. All equipment tag numbers with equipment name will be painted on large equipments or else SS tag plates bearing tag numbers will be hung on all small equipments like valve, strainers tec. Items such as valves, etc. which are subject to hand operation, will be provided with name plates so constructed as to remain clearly legible throughout the life of the SG giving due consideration to the difficult climatic conditions to be encountered. Nameplates will be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment.
3. All trade name plates and labels will be in English language. All measurements will be in M.K.S/SI Units.

2.4 Safety and Security

1. The design will incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and property. The design will comply with all appropriate statutory regulations relating to safety.
2. Ready and safe access will be provided to all equipment of the SG and auxiliaries for inspection, cleaning and maintenance.
3. The use of explosive, toxic or otherwise hazardous materials etc will be kept to a minimum during construction and the design of the SG & minimise requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions will be taken in the design, manufacture and layout of equipment to minimise the potential hazard, and all equipment, gadgets and accessories necessary for the protection will be provided. Usage of asbestos or any other banned material in any form is not permitted.

2.5 Guards

1. Effective guards and fences must be provided for the equipment as may be necessary for safe operation & maintenance to prevent accidents.
2. Steel mesh guards of suitable gauge which allow visual inspection of equipment with the guard in place are generally preferable. The guards will be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and galvanised. The guards will be so designed to facilitate easy removal and replacement during maintenance.
3. All drive belts, couplings, gears and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.
4. Guards for couplings and rotating shafts of approved standard.

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2.6 Location and Layout Requirements

1. The majority equipment of SG island (except otherwise specified) will all be of outdoor installation. Layout should facilitate access for operation, maintenance and inspection of any equipment/components without disturbing the operation of rest of the plant.
2. The Contractor will try to retain the layout as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Contractor may, subject to Owner's/Consultant approval after the same to suit the space requirement of the equipment offered.
3. Contractor may suggest as an alternative his own preferred layout clearly indicating the relative merits, if any. Such alternative will be submitted to Owner/Consultant in terms of techno commercial consideration.

2.7 Operation, Maintenance & Availability Considerations

1. Equipment/works offered will be designed for high availability, high reliability, low maintenance and ease of operation & maintenance. The Contractor will specifically state the design features incorporated to achieve high degree of reliability, availability, operability and ease of maintenance. He will also furnish details of performance parameters of SG and auxiliaries stated in his reference list.
2. Sufficient space for ease of operation and maintenance will be provided. All valves, gates, dampers and other devices will be located and oriented in such a way that they are accessible from operating floor levels.
3. The design and engineering, while choosing equipment will include, where possible, to ensure interchange ability of parts or components so as to minimise inventory.

2.8 Materials

1. In selecting materials of construction of equipment, the Contractor will pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. All materials will be new, and will be of the quality most suited to the proposed application.
2. As far as possible, materials will be in accordance with national or international standard specifications and will be used in accordance with national or international codes of practice. Where such standards or codes of practice are not available sufficient information will be provided to allow the Owner/Consultant to assess the suitability of the material for the particular application.
3. All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions will be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the SG and auxiliaries.

2.9 Lubrication

1. Provision will be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

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2. Non ferrous capillary tubing will be used throughout.
3. Gear boxes and oil baths will be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication will be provided.
4. All high speed gears will be oil bath lubricated. Low speed gears will be lubricated by means of soft grease. Removable and accessible drip pans will be provided to collect lubricant which may drop from operating parts.
5. All lubrication points will be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication will be fitted.
6. The Contractor will supply grease gun equipment suitable to service each type of nipple fitted.

2.10 Lubricants and Control Fluids

1. The Contractor will provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the SG and auxiliaries. A sufficient supply of these will be provided by the Contractor for initial commissioning, first fill and upto successful completion of trial operation.
2. The Contractor will supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids will be provided. The Contractor will endeavour to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids will be of internationally recognised standards and will be easily obtainable from a large number of suppliers. Contractor will also indicate the equivalent Indian Standard for the above for easy procurement in future.
3. No lubricant or control fluid will have toxic or other harmful effects on personnel or on the environment.

2.11 Operation and Maintenance

1. The SG and auxiliaries will be designed and constructed so that operation and maintenance manpower requirements are minimised.
2. Spare parts for equipment will be interchangeable with the original components.
3. All similar standard components/parts of similar standard equipment provided will be interchangeable with one another. Further identical equipments will be provided for similar duties so that the same are interchangeable with one another in totality and component wise.
4. On completion of commissioning, a complete set of tools for the maintenance of the entire SG and auxiliaries will be provided by the

Contractor. Tools used during erection and commissioning will not be accepted except with the specific approval of the Owner/Consultant.

2.12 Life and Mode of Operation

The steam generator and auxiliary equipment apart from being capable of operation on base load will also be suitable for cyclic load variation. However, continuous operation of the Plant under cyclic modes may also be required for it to participate in automatic load frequency control system. In design consideration and criteria for cyclic operation of the Unit it will be ensured that under such operating condition, no portion of the steam generator and auxiliaries will be stressed beyond acceptable safe thermal stress and fatigue levels based on cyclic loading, number of cold, warm & hot starts, likely variations in steam parameters etc. For ensuring these requirements the Unit will be equipped with adequate temperature measurements, the signal for which will be suitably processed to give guidance to the Operator to regulate loading within permissible rates from time to time.

The SG and auxiliaries will be designed for the range of operational flexibility associated with the above duty conditions.

2.13 Packaging & Marking

The identification marking indicating the name and address of the consignee will be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor will include in the marking gross and net weight, outer dimension and cubic measurement. Each package will be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

2.14 Protection

Equipment having antifriction or sleeve bearings will be protected by weather tight enclosures. Coated surfaces will be protected against impact, abrasion, discoloration and other damages. Surfaces which are damaged will be repainted.

Electrical equipment controls and insulations will be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items will be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other substantial type covering to ensure their full protection. All exposed threaded parts will be greased and protected with metallic or other substantial type protectors.

All piping, tubing and conduit connections on equipment and other equipment openings will be closed with rough usage covers or plugs. Female threaded openings will be closed with rough usage covers or plugs. The closures will be taped to seal the interior of the equipment. Open ends of piping, tubing and conduit will be sealed and taped.

Returnable containers and special shipping devices will be returned by the manufacturer's field representative at the Contractor's expense.

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2.15 Environment Protection and Noise Level Requirement

2.15.1 Environment Protection

The SG and auxiliaries will be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control will be ensured by the Contractor to restrict air and water pollution within the stipulated limits as mentioned below and in accordance with Environment (Protection) Rules 1986 as amended till date.

In case the Ministry of Environment & Forest stipulate additional conditions not specified hereunder while clearing the project will be complied with the SG by the Contractor.

For Water Quality

a) Conform to MINAS (Minimum National Standards) & IS: 2490.

b) Specific requirement of State Pollution Authorities over and above the above stipulation.

For Air Quality

a) Suspended Particulate Matter - 50 mg/Nm^3 at chimney outlet.

b) NOx - less than 260 gm/GJ of heat input at reference O_2 level of 6% at APH outlet

In absence of Standard emissions in India, for certain gaseous emissions in India, internationally accepted World Bank Standard is to be followed. The Contractor will include in his scope all equipment and measuring instruments to comply with above standards. Location and accessibility of the instruments will be properly co-ordinated.

2.15.2 Noise

The plant will be designed, and supplemented with suitable acoustic measures to ensure desired/ stipulated noise level criteria as per the recommendation of OSHA standards or as per the following stipulations, whichever is stringent.

a) Maximum noise level will not exceed 85 dB (A) for all running equipments and 92 dB (A) for beater wheel mills when measured in1.0M away from the noise emission source in accordance with ISO 3746. OR meet the requirement of Pollution Control Board norms, whichever is stringent)

b) Any statutory changes in stipulations regarding noise level that may be warranted in future by State Pollution Control Board or Central Pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the Contractor will comply with the same.

Excluded from the noise requirements are the boiler transient conditions such as SG start-up, shut down, HP bypass operation, pressure relief valve and safety valve operation.

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2.15.3 "Intentionally deleted."

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SCHEDULE – 10

GENERAL TERMS AND CONDITIONS OF THE CONTRACT

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SCHEDULE-10

GENERAL TERMS & CONDITIONS OF CONTRACT

10.1 Bank Guarantees

10.1.1 General

1. All the Bank Guarantees shall be irrevocable and shall be from any nationalised / scheduled Bank in India authorized by Reserve Bank of India, other than Bank of China, acceptable to the Purchaser and drawn in favour of NLC Limited Neyveli.

   All the Bank Guarantees are to be furnished by the Bank directly to the Purchaser through RPAD/Speed Post/Courier.

2. The Bank Guarantee shall be as per respective format prescribed and shall be submitted on Non-judicial stamp paper of appropriate value and the stamp paper shall be in the name of the Bank.

3. All the Bank Guarantees shall be payable on first demand, without demur, irrespective of any legal dispute between the Bank and the Contractor to the Purchaser without any condition or dispute whatsoever.

4. The Contractor shall arrange to keep alive the several bank guarantees referred to herein for the requisite duration by making timely request to the Bank or Banks concerned. All the extension / amendments for Bank Guarantees also shall be on non-judicial stamp paper of appropriate value obtained in the name of Bank.

5. No interest or any bank charges shall be payable by the Purchaser in respect of any Bank Guarantee furnished by the contractor in respect of this contract with respect to the period upto completion of all obligations under the Contract by the Contractor.

6. The Purchaser shall have the right to en-cash the Bank Guarantees for non-compliance of any or all the terms and conditions of the contract. Non - compliance of any or all the terms and conditions of the contract by the Contractor, will be intimated to the Contractor, specifying the reason with supporting documents, before encashment of the Bank Guarantee.

10.1.2 Bank Guarantee for Advance Payment (APG)

The advances stipulated in the payment terms shall be made to the Contractor by the Purchaser subject to the Contractor providing a bank guarantee for 110% of the advance amount as per the stipulations and Purchaser's acceptance of the said bank guarantee. The bank guarantee shall be valid till the completion of respective scope of work with a grace period of 2 (two) months thereafter. The bank guarantee value shall be reduced on the basis of actual recovery of advances from the bills of respective scope of work on quarterly basis. Proforma for Bank Guarantee for Advance Payment is in Annexure-XV.

10.1.3 Contract Performance Guarantee (CPG)

1. The Contractor shall submit an irrevocable Contract Performance Bank Guarantee within 30 days from the date of Letter of Award.

2. The Contractor shall furnish to the Purchaser, Bank Guarantee in the prescribed pro-forma towards Contract Performance for a value of ten (10) per cent of the Contract price plus price variation if any, in favour of the Purchaser. The Bank Guarantee shall be for the time bound, due and faithful performance of the contract and shall remain binding notwithstanding such variations, alterations or extensions of time as may be made, given, conceded or agreed to between the Contractor and the Purchaser under these General Terms & Conditions or otherwise. The Bank Guarantee shall be from a Nationalised / Scheduled Bank in India. The Bank Guarantee towards Contract Performance shall be subject to approval of the Purchaser thereafter. The Contractor shall ensure that the Contract Performance Bank Guarantee remain valid till the expiry of the guarantee period of the Contract plus three months grace period. The Contract Performance Bank Guarantee submitted by the Contractor as above and accepted by the Purchaser is enclosed at Annexure-XIV in Contracts - I, II & III.

3. The Contract Performance Bank Guarantee furnished by the Contractor will be subject to the terms and conditions of the Contract. The Purchaser will not be liable for payment of any interest on the Contract Performance Guarantee or depreciation thereof.

4. The Contract Performance Bank Guarantee shall be released on application by the Contractor within ninety (90) days after the expiry of the warranty period and after the Contractor has discharged all his obligations under the Contract including release of Custom Bond and produced a "No Demand Certificate" from the Purchaser. The Purchaser shall not unreasonably withhold the issue of "No Demand Certificate" after receipt of request for the same.

5. The performance guarantee shall cover additionally the following guarantees to the purchaser:

   (i). The Contractor guarantees the successful and satisfactory operation of the equipment furnished under the contract as per the specification and documents.

   (ii). The contractor further guarantees that the equipment provided and installed shall be new and free from all defects in design, material and workmanship. The Contractor shall upon written notice from the purchaser, fully remedy free of expenses to the purchaser such defects as may develop under normal use of the said equipment within the period specified in the contract.

   (iii). The Contractor also guarantees the proper performance of the steel structures, for a period of twelve (12) months from the date of final takeover of the plant and equipment. Any defect found during this period will be made good by the contractor at his own cost failing which the purchaser reserves the right to take remedial measures at the contractors' risk and cost.

6. The Purchaser shall have the fullest liberty to lodge their claim for encashment of the guaranteed sum either in full or part, in the manner suitable to them, by intimating the Contractor specifying the reasons with supporting documents, before encashment of the Bank Guarantee. However, payment made for a

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sum lesser than the guaranteed amount shall not relieve or discharge the bank from their obligations guaranteed under the bank guarantee, till the contractual obligations or fully performed by the Contractor or the Bank Guarantee is discharged by the Purchaser, as the case may be under the Bank Guarantee shall continue to be in force till such time.

7. Deleted.

10.1.4 Retention Money Bank Guarantee (RMBG)

If the Performance Guarantee (PG) tests and the Final Takeover is delayed beyond six months from the schedule due to reason not attributable to Contractor, final 10% / 5% for supply /erection/civil works as stated in the terms of payment shall be released against production and acceptance of bank guarantee (as per the Retention Money Bank Guarantee format enclosed as per Annexure-XIX of this Volume-I) for an equal amount valid for one year or the revised schedule date of performance guarantee tests and Final takeover whichever is earlier. If the PG tests and Final Takeover gets delayed further due to reasons not attributable to the Contractor then further extension of validity of the Bank Guarantee, beyond one year, shall be mutually discussed and agreed.

10.1.5 Financial Back-up Bank Guarantee

The financial back up guarantee, by the Associate M/s. Alstom Boiler Deutschland GmbH, Germany furnished to the Purchaser for a value of 5% of their respective portion of the work, valid till the expiry of the guarantee period of the Contract plus three months grace period is enclosed at Annexure-XXIII in Contracts - I, II & III. The Purchaser shall have the right to encash the financial backup bank guarantee for non-compliance of any or all the terms and conditions of the Letter of Consent as per Annexure-XXI, as well as for shortfall in guaranteed values applicable for Steam Generator as enumerated in the contract.

10.1.6 Liquidated Damages Bank Guarantee (LDBG)

Liquidated Damages levied towards non-fulfillment of time schedule as per Schedule-4 of this Volume-I may be considered for release as under:

90% of the withheld/ leviable Liquidated Damages amount may be considered for release against submission of Liquidated Damages BG for 100% amount withheld/ leviable and acceptance by the Purchaser (as per Annexure-XXIV of this Volume-I).

10.2 Licences

10.2.1 Import Licence

Intentionally deleted.

10.2.2 Export Licence

Intentionally deleted.

10.3 Insurance

The Contractor shall take insurance policies as mentioned below and the same shall be submitted to the Purchaser for approval failing which the progressive payment of 65% as per Schedule – 6 of Supplies Contract, will not be effected.

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10.3.1 Marine cum Erection (MCE) Insurance

1. The Contractor shall take Marine-cum-Erection insurance policy against all risks to the equipment /materials during handling, transit (marine and inland), storage, erection, testing and commissioning for the total contract price including price variation. The period of policy shall commence from the despatch of first consignment of equipment/materials for the work and continue during transit, storage, erection at site till completion of testing commissioning and upto Provisional Takeover of the second unit as per Contract. After Provisional Takeover of the first unit, the sum insured value can be reduced to that extent.

   Alternatively, the Contractor may take a Transit / Marine Insurance policy and a Storage-cum-Erection Insurance policy against all risks to cover the loss or damage during Transit and Storage & Erection respectively. The sum insured under the policy shall represent the cost of equipment / materials supplied by the Contractor for the work. The sum insured under the Storage-cum-Erection policy shall represent the complete erected value of Plant & Equipment including freight, insurance, taxes and duties and erection cost.

   If the Contractor is already having an open Transit /Marine Insurance policy, the copy of the same shall be furnished.

2. The Contractor shall also take additional covers (Add-On covers) given under MCE insurance like Third Party Liability, Surrounding properties, Clearance and Removal of debris, Cross liability, Additional Customs Duty, Express Freight, Extended Maintenance Cover upto Final Takeover, etc. The sum insured for such Add-On covers shall be decided by the Contractor based on its assessment and risk involved in the contract.

3. Risks to be covered by insurance shall not be limited merely to the items mentioned above. The Contractor shall arrange for insurance of any other risks he may deem prudent, but the expenses thereof shall be to the account of the contractor only.

4. If necessary, Transit and storage (all risks) insurance coverage for additional transit involved for sending equipment/material to Sub-Contractor/ Fabricator's shop for fabrication/ reprocessing and receiving back at site shall be taken.

5. The form and the limit of such insurance as defined shall be acceptable to the Purchaser. However, irrespective of such acceptance, the responsibility to maintain insurance at all times during the required period and for the required value shall be that of the Contractor alone. The Contractor's failure in this regard shall not relieve him of any of his contractual responsibilities and obligations.

6. The transfer of title shall not in any way relieve the Contractor of the above responsibilities during the period of the contract. Any loss or damage to the equipment during handling, transporting, storage and erection, till such time the plant is provisionally taken over (Provisional Takeover) by the Purchaser, shall be to the account of the Contractor. After all the instalments of premium are paid, on Provisional Takeover of the plant, the difference between the lumpsum charges indicated in Schedule-3 Contract Price and the premium actually paid to the Contractor shall be paid to the Contractor on

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the basis of invoices from the Contractor without supporting documents, The Contractor shall be responsible for preferring of all claims as applicable and make good at the Contractor's own cost for the damage or loss by way of repairs and/or replacement of the portion of the works damaged or lost for the timely commissioning of the equipment/ completion of the works. Licenses, clearance etc., if any required for the purpose of replacement of equipment lost/damaged in transit and/or during storage, erection, shall be made available by the Contractor.

7. The contractor shall provide the purchaser with priced copy of all insurance policies and documents taken out by him in pursuance of the contract. All copies of such documents shall be submitted to the purchaser immediately after such insurance coverage for approval.
8. The Contractor shall also inform the Purchaser in writing at least 60 days in advance regarding the expiry cancellation and/or change in any of such documents and ensure revalidation/renewal etc, as may be necessary well in time.
9. The Insurance policy shall provide for payment of claim both in foreign currency and Indian Rupees.
10. The Purchaser shall be the principal holder of the policy along with the Contractor the Purchaser reserves the exclusive right to assign the Policy.
11. All costs on account of Insurance charges/premium on lumpsum and firm price basis shall be indicated in the price schedule. The premium receipt issued by the Insurance Company shall have to be produced for claiming the payment. However, the total premium to be reimbursed shall be restricted to the lumpsum agreed to in the price schedule in the contract. However, the Contractor's responsibility to maintain the insurance cover as per the terms of contract at his cost will not cease after reaching the lumpsum quoted. After all the instalments of premium are paid, the difference between the lumpsum charges indicated in the price schedule and the premium actually paid to the Contractor will be paid to the Contractor on the basis of invoices from the Contractor without supporting documents on Provisional Takeover.

10.3.2 Workmen's Compensation Insurance

The Contractor shall take Workmen's Compensation Insurance for this project work. This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India) as amended from time to time. This policy shall also cover the Contractor against all claims for injury, disability, disease or death of his or his Sub Contractor's employees which for any reason are not covered under the Workman's Compensation Act, 1948. The liabilities shall not be less than:

- Workmen's compensation: As per statutory provisions.
- Towards Employees Liability: As per statutory provisions.

The Contractor shall provide the Purchaser with a copy of Workmen Compensation insurance policies taken out by him in pursuance of the Contract.

10.3.3 The Contractor taking Insurance policies for the total contract price indicated in the contract but only for part period or part liabilities which shall result in non

fulfillment of contractual conditions for the whole period of the contract or failure to cover all liabilities shall attract penalty recovery from the Contractor as deemed fit as decided by the Purchaser.

10.4 Customs Clearance

Intentionally deleted.

10.5 Liquidation, Death, Bankruptcy etc.

10.5.1 If the Contractor shall die, dissolve or become bankrupt or insolvent or cause or suffer any receiver to be appointed on its business or any assets thereof with its Creditors, or being a corporation commence to be wound up, not being a member's voluntary winding up for the purpose of amalgamation or reconstruction, or carry on its business under a Receiver for the benefits of its Creditors or any of them, the Purchaser shall be at liberty:

(a). to terminate the Contract forthwith upon coming to know of the happening of any such event as aforesaid by notice in writing to the Contractor or to the Receiver or Liquidator or to any person in whom the Contract may become vested to, or

(b). to give such Receiver, Liquidator or other person the option of carrying out the Contract subject to his providing a guarantee upto an amount to be agreed for the due and faithful performance of the Contract.

10.6 Responsibility for Performance of Contract

1. The Contractor shall be responsible for the due and faithful performance of the Contract in all respects according to the drawings, specifications and all other documents referred to in this Contract. Any approval which the Purchaser/Consultant may have given in respect of the drawings/documents, specifications, stores, materials, supplies or other particulars and the work or the workmanship involved in the Contract (whether with or without test carried out by the Contractor or the Purchaser) shall not relieve the Contractor from its obligations and notwithstanding any approval or acceptance given by the Purchaser/ Consultant, it shall be lawful for the Purchaser to reject the material on arrival at site, if it is found that the materials supplied and/or erection and/or construction work carried out by the Contractor are not in conformity with the terms and conditions of the Contract in all respects.

2. The Contractor shall co-operate with the Purchaser's other contractors, if any, for any associated plant and freely exchange all relevant technical information with them to obtain the most efficient and economical design and to avoid unnecessary duplication of equipment. The Contractor shall also coordinate with other contractors for any interface activity at his battery limits. No remuneration shall be claimed from the Purchaser for such technical cooperation.

10.7 Responsibility for Completeness

1. Any supplies and services which might not have been specifically mentioned in the Contract but are necessary for the design & engineering, supply, erection, commissioning, performance and/ or completeness of the works, shall be supplied/provided by the Contractor without any extra cost

to the Purchaser within the time schedule for efficient and smooth operation and maintenance of the works under Indian conditions, unless expressly excluded from the scope of supplies and services in this Contract.

2. The approval by the Purchaser/Consultant at any stage for any supplies and services by the Contractor shall not relieve the Contractor of its obligations.

10.8 Despatch and Billing Schedule

1. The Contractor shall prepare a detailed Billing-cum-Despatch Schedule in the logical sequence required for services within the overall delivery schedule of the Contract. Billing-cum-Despatch schedule for the Plant and Equipment shall be submitted within 60 days from the date of Letter of Award of the Contract. Detailed shipping schedule shall be submitted within 6 months from the Letter of Award of Contract indicating the breakdown of the complete Plant into shipment units with approximate weights and dimensions and the respective dates upon which such units will be despatched from the Contractor's and/or his Sub-Contractor(s) works.
2. The Billing-cum-Despatch Schedule and the Shipping Schedule is subject to approval of the Purchaser/Consultant. Six (6) copies of the approved Billing-cum-Despatch Schedule and Shipping Schedule shall be submitted to the Purchaser within 15 days from the date of approval.
3. No early payment shall be made for non-sequential or early delivery of any Plant & Equipment which will be required for erection at a later date. Further, the early delivery of such equipment will occupy storage space, which will be the responsibility of Contractor.
4. The lapse of guarantee due to delay in performance guarantee test of any such equipment, if it is supplied by any associate/sub-vendors, is the responsibility of the Contractor.

10.9 Shipping Notes and Documents

10.9.1 Shipment Notification: Intentionally deleted

10.9.2 Transport

1. Ocean transportation and shipping procedure for imported equipment:
   (a). The Contractor shall furnish to the Purchaser at least 3 months before the commencement of the supplies a programme of despatches as scheduled by the Contractor to enable the Purchaser to have an effective follow up. Part shipment is permitted.
   (b). The Contractor shall furnish a list of items with value of goods imported through Chennai Port and furnish concerned detailed information at least 3 (three) months prior to the actual date of commencement of supplies.
   (c). The terms of the Contract, being on FOB basis the goods at the time of shipment will be the Cargo of Government of India. The Contractor shall make shipping arrangements through the Ministry of Surface Transport, Transport Bhawan, 1, Parliament Street, New Delhi – 110 001 through

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their respective forwarding agents/nominees as mentioned below. Adequate notice of not less than 6 (six) weeks, on the readiness of cargo for shipment, should be given by the Contractor from time to time for finalising the shipping arrangements. While giving such notice of readiness, the Contractor shall furnish the following in triplicate to the forwarding agent and Ministry of Surface Transport under intimation to the Purchaser:

(i). Contract No.

(ii). Brief description of material to be shipped.

(iii). Gross weight.

(iv). Net weight.

(v). Dimensions of the packages to be shipped.

(vi). Number of packages.

(vii). Import Licence No., if any and L/C particulars.

(d). The freight forwarder shall thereafter communicate to the Contractor, the name of vessel and estimated time of sailing to enable the Contractor to transport the items to the port of shipment and deliver them at port. The Contractor shall also handover the necessary shipping documents to the freight forwarder simultaneously.

S.No	Area	Forwarding Agent / Nominee
1	UK- including Northern Ireland, Eire, the North Continent of Europe (West Germany, Holland, Belgium, France Norway, Sweden, Finland and Denmark) and ports on the Continental Sea-board of the Mediterranean (i.e. France and Western Italian ports) and also Adriatic ports.	M/s Panalpina World Transport, Panalpinawelt Transport GmbH, Spaldingstr-64, D20097, Hamburg Tel No:. +49 4023771-133, Fax No: +49 4023771-342 OR 344
2	USA & Canada	M/s OPT, Overseas Project Transport Inc. 46, Sellers Street Kearny, N.J. 07032, U.S.A. Tel: (201)998-7771 Fax: (201)998-7833 Telex: 673-3586 Opt
3	Japan	The first Secretary(Commercial) Embassy of India, Tokyo, Japan Cable: INDEMBASSY: TOKYO
4	South Korea	The first Secretary (Commercial) Embassy of India, San-2-1,Bokwang-Dong, Yongsen-Ku, (Behind Bowling Centre) Seoul, South Korea

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S.No	Area	Forwarding Agent / Nominee
5	Russia	The Secretaries, Indo-Soviet Shipping Service, C/o The Shipping Corporation of India Ltd., "Shipping House" 245 Madame Cama Road, Bombay- 400021 Cable: SHIPINDIA: BOMBAY FOR SOVINDSHIP Fax:(022)202 2949/6905 Tele:(022)202 6666
6	Poland	The Secretaries, Indo-Polish Shipping Service, C/o. The Shipping Corporation of India Ltd. "Shipping House", 245 Madame Came Road, Bombay 400021, Cable: SHIPINDIA: BOMBAY FOR SOVINDSHIP) FAX: (022)
7	Other Areas	The Shipping Coordination Officer, Ministry of Surface Transport (Chartering Wing) New Delhi Cable: TRANSCHART, New Delhi Fax: 011-3718614/3352726

(e). The Contractor shall approach the above shipping agencies. If the terms & conditions of shipping agencies are not feasible to the Contractor, the same shall be informed to the Purchaser and with the approval of Purchaser, Contractor may arrange other shipping agencies. The Purchaser will give such approval with out delay.

2. If situation warrants, the Contractor may arrange air freight with prior approval of the Purchaser. In such case the increase in freight and customs duties thereof shall be to the account of Contractor.

3. All shipments will be done through approved vessels as per the `Institute of London Classification Clause' of the Institute of London /Underwriters' Institute Classification Clause as given below.

4. The Marine Transit rates agreed for this insurance apply only to cargoes and/or interests carried by mechanical self-propelled vessels of steel construction, classed as below by one of the following classification societies.

• Lloyds Register	-	100A1 or BS*	
• American Bureau of shipping	-	*A1	R
• Bureau Veritas	-	13/3E*	V
• Germanischer Lloyd	-	*100A^4	G
• Korean Register of shipping	-	*KR S1	J
• Nippon Kaiji Kyokai	-	NS*	N

• Norske Veritas	-	1A1	N
• Registro Italiano	-	*100A 1.1 Nau	L
• Register of shipping of the USSR	-	KM*	S
• Polish Register of shipping	-	*KM	P

Provided such vessels are:

(i). Over 15 years of age but not over 25 years of age and have established and maintained a regular pattern of trading on an advertised schedule to load and unload at specified ports.

(ii). Chartered vessels and also vessels under 1000 GRT which are mechanically self propelled and of steel construction must be classed as above and not over 15 years of age. And for the Chartered vessels of 15 years of age the Contractor shall produce a certificate as follows:

"The shipment by sea-worthy vessels classed 100 A1 Lloyds or equivalent classification society and approved by General Insurance Company of India".

If the suppliers do not adhere to the above condition and if the insures charge extra premium due to overage or non-classification of vessels, the suppliers may have to be held liable to pay the extra premium incurred.

5. The bills of lading should be drawn so as to show:

SHIPPER	:	THE GOVERNMENT OF INDIA
CONSIGNEE	:	PROJECT MANAGER - NNTPP 2x500 MW,NEYVELI NEW THERMAL POWER PROJECT NEYVELI, CUDDALORE DISTRICT, TAMIL NADU, INDIA
PORT CONSIGNEE	:	ADDRESS OF CONTRACTOR / CLEARING AGENT OF CONTRACTOR
IMPORTER	:	PROJECT MANAGER -NNTPP 2x500MW, NEYVELI NEW THERMAL POWER PROJECT NEYVELI, CUDDALORE DISTRICT, TAMIL NADU, INDIA

6. The Contractor shall forward the non-negotiable copy of the bill of lading indicating the gross freight amount and rebate allowed to the Shipping Co-ordination Officer, Ministry of Transport, Department of Surface Transport, New Delhi immediately once the shipment of each consignment is effected.

10.9.3 Shipping Documents for Imported material

1. The Contractor shall send the following negotiable shipping documents to the Purchaser:

(a). Three (3) original and 6 (six) copies of clean bill of lading or one (1) clean Airway Bill & 3 (three) copies, in case of air freight.

(b). One (1) original & five (5) copies of Contractor's signed invoices.

(c). Six (6) copies of packing list.

(d). Six (6) copies of certificate of' country of origin

(e). Six (6) copies of Purchaser's dispatch clearance.

Dispatch clearance shall be provided automatically on inspection at works against last hold point in Quality Plan. For the cases where the scrutiny and review by the Consultant is required, the same will be indicated in the QAP after mutual discussion and agreement

(f). Six (6) copies of inspection certificate, if any, issued by the Purchaser/his authorised representative.

(g). Six (6) copies of certificate from the Contractor to the effect that drawings and catalogues for customs clearance purpose have been kept with the packages for shipment.

(h). Six (6) copies of certificate from the Contractor to the effect that the contents in each case are not less than that entered in the invoices and guaranteed as new and as per the relevant technical specifications.

The Contractor shall distribute to the Purchaser the following documents:

- Bill of lading (two copies)
- Shipping Specification (one copy)
- Quality Certificate (one copy)

(i). Approved Test Certificates if any with the cargo

- Quality certificate (one copy)
- Packing list (6) copies comprising 2 copies in case No.1 of each consignment of the goods and 4 copies in each case (three inside the Box and one copy in a special packet at the outer side of the Box).

2. The negotiable shipping documents shall be handed over to the Indian Contractor by the Purchaser. The Contractor shall prepare the bill of entry based on the original documents and get it assessed by Custom Authority.

3. After port clearance and custom clearance the Contractor's responsibility shall be taking the delivery of materials from port, subsequent handling, transportation and storage at site against submission of the Custody-cum-Indemnity Bond for full value of supplies in the Purchaser's approved proforma.

4. The demurrage/port charges, if any, on account of the delay in unloading the materials/port clearance / delayed receipt of negotiable document by Purchaser shall be borne and paid by the Contractor. Port of Destination shall be Chennai Port, TamilNadu, India.

10.9.4 Shipping documents for Indigenous Materials

1. **General**

The consignee for both rail and road despatches shall be clearly marked as NLC, 2x500MW Neyveli New Thermal Power Project (NNTPP), Tamilnadu, India.

The Contractor shall arrange to despatch the following documents to:
PROJECT MANAGER – NNTPP, NLC LTD, 2x500 MW NEYVELI NEW THERMAL POWER PROJECT, NEYVELI - 607 801, TAMIL NADU, INDIA

(a). One (1) original and five (5) copies of the clean rail/lorry receipt. In case of non availability of Original Rail / Lorry receipt, 65% payment shall be released, on receipt of materials at site.

(b). One (1) original and five (5) copies of Contractor's signed invoice.

(c). 6 (six) copies of Challan and Packing List.

(d). 6 (six) copies of inspection certificate, if any issued by the Purchaser.

(e). 6 (six) copies of Purchaser's dispatch clearance

(f). 6 (six) copies of Approved Test Certificates if any.

The RR/Challans duly endorsed by the Purchaser will be handed over to the Contractor for taking delivery of materials from Railway/Trucks unloading the same from wagons/ trucks and subsequent handling, transportation and storage at site after submission of custody-cum-indemnity bond in Purchaser's approved proforma. The demurrage charges, if any, will be payable by the Contractor.

2. By Wagons

In case of despatch of materials in railway wagons, the Contractor shall ensure that the following are observed by them and their Sub-Contractors.

(a). Identify, place necessary indents on the railways and obtain at the appropriate time the correct type of wagons required, keeping in view the consignments to be despatched.

(b). In case of over dimensioned consignments, the Contractor shall obtain the sanction for movement of the O.D. Consignment from the railways.

(c). Non-availability of special wagon or handling equipment shall not be an excuse for payment of demurrage and if so it shall be to the Contractor's account.

(d). Care being taken to avoid all possible chances of damages during transit and to ensure that all packages are firmly secured.

(e). The destination shall be clearly marked.

3. By Road

In case of the consignments despatched by road, the Contractor shall ensure that the following are observed by himself and the Sub-Contractors:

(a). Identify and obtain the correct type of trucks/trailors, keeping in view the nature of consignments to be despatched.

(b). Care being taken to avoid all possible chances of damages during transit to ensure that all packages are firmly secured. .

(c). In case of over dimensioned consignments, the Contractor shall obtain the sanction for movement of the O.D. Consignment. Contractor shall make all out efforts to obtain the required sanctions. However, in case there is a ban on movement of such consignments by Central / State

Govts. or any other statutory body, the implication of the same on deliveries shall be mutually discussed and agreed.

(d). Non-availability of special trucks or handling equipment shall not be an excuse for payment of demurrage and if so shall be to the Contractor's account.

(e). All consignment despatched by road shall be on "door delivery" and freight paid basis.

(f). The destination shall be clearly marked.

10.10 Packing, Identification and Markings

1. The Contractor shall include and provide for securely protecting and packing the materials so as to avoid loss or damage during handling & transport by air, sea, rail and road.

2. All packing shall allow for easy removal and checking at site. Special precaution shall be taken to prevent rusting of steel and iron parts during transit by sea. Gas seals or other materials shall be adopted by the Contractor for protection against moisture during transit.

3. The number of each package in a shipment shall be shown in fraction, numerator showing number of the package and the denominator showing total number of packages in a lot / consignment. The packages number shall be generally prepared in the sequence in which they will be required for erection.

4. Each package delivered under the Contract shall be marked by and at the expense of the Contractor and such marking must be distinct and in English language (all previous irrelevant markings being carefully obliterated). Such marking shall show the description and quantity of contents, the name and address of consignee, the gross weight and net weight of the package, the name of the Contractor with a distinctive number of mark sufficient for purposes of identification. All markings shall be carried out with such materials as to ensure quickness of drying, fastness and indelibility. Each equipment or parts of equipment shall, when shipped or railed or otherwise despatched be tagged with reference to the assembly drawings and corresponding part numbers. Each bale or package shall contain a packing note quoting specifically the name of the Contractor, the number and date of contract and the name of the office placing the contract, nomenclature of the stores and include a schedule of parts for each complete equipment giving the part numbers with reference to the assembly drawing and the quantity of each part, drawings nos. and tag numbers.

5. Rotor bearings should not be used as a support while packing.

6. Besides wherever necessary, packing shall bear a special marking "TOP", "BOTTOM", "DO NOT TURN OVER", "KEEP DRY", "HANDLE WITH CARE", etc.

7. All packing cases, containers (excluding marine container), packing and other similar materials shall be new.

8. Notwithstanding anything stated in this clause, the Contractor shall be entirely responsible for loss, damage or depreciation or deterioration to the materials & supplies due to faulty and/or insecure packing.
9. One copy of respective standard manufacturer's erection instruction/operation instruction manual shall be kept in each package/container for immediate reference.
10. Each and every package box shall be marked with the following, as a minimum:
    (i). Name and address of Consignee :
    (ii). Project reference :
    (iii). Contract No.:
    (iv). Packing No.: (1/10, 2/10, 3/10 ..... when there are 10 packages for one consignment)
    (v). Net Weight/Gross Weight :
    (vi). Port of Loading :
    (vii). Destination Port : Chennai
    (viii). Packing Mark : [symbols indicating "TOP" and other special markings as per clause 10.10.(4) & 10.10.(6) above]
    (ix). Type of Equipment :
    - "E" (for Equipment supply)
    - "T" (for Tools & Tackles)
    - "S" (for Mandatory Spares)

10.11 Type, Quality of Materials and Workmanship

1. The Contractor shall be deemed to have carefully examined and to have knowledge of the equipment, the general and other conditions, specifications, schedules, drawings, etc. forming part of the Contract and also to have satisfied himself as to the nature and character of the work to be executed and the type of the equipment and duties required including wherever necessary of the site conditions and relevant matters and details. Any information thus procured or otherwise obtained from Purchaser/Consultants shall not in any way relieve the Contractor from his responsibility and contractual obligations for designing, manufacturing and supplying the Plant and Equipment at site and executing the work in terms of the Contract. If the Contractor shall have any doubt as to the meaning of any portion of the Contract, he shall before signing it set forth the particulars thereof and submit to Purchaser in writing in order that such doubt may be removed.
2. The Equipment under scope of supply shall be of the best quality and workmanship according to the latest engineering practice and shall be manufactured from materials of best quality considering strength and durability for their best performance. All material shall be new. Substitution of specified material or variation from the method of fabrication may be permitted with the prior written approval of the Purchaser.

3. The Contractor shall procure and/or fabricate all materials and equipment in accordance with all requirements of Central and State enactments, rules and regulations governing such work in India and at site. This shall not be construed as relieving the Contractor from complying with any requirement of Purchaser as enumerated in the Contract Specifications which may be more rigid than and not contrary to the above mentioned rules, nor providing such construction as may be required by the above mentioned rules and regulations. In case of variance of the Contract Specification from the laws, ordinance, rules and regulations governing the work, the Contractor shall immediately notify the same to the Purchaser. It is the sole responsibility of the Contractor, however, to determine that such variance exists. Wherever required by rules and regulations, the Contractor shall also obtain the Boiler Inspector's/ Central Electrical Authorities / Statutory Authorities' approval for the plant, machinery and equipment to be supplied by the Contractor.
4. Codes and standards referred in Contract documents shall be followed. Codes and standards of other countries can be followed with the prior written approval of Purchaser, provided materials, supplies & equipment according to the standard are equal to or better than the corresponding standards specified in the Contract.
5. All meters, gauges, recorders and other types of indicating, integrating or recording devices shall be calibrated in metric system and degree Celsius. Where vernier attachments are related, English system gearing must be changed to produce result on a true decimal (metric basis). Functional and instruction plate shall be in English language.
6. Brand names mentioned in the Contract documents are for the purpose of establishing the type and quality of products to be used. The Contractor shall not change the brand name and qualities of the bought-out-items without the prior written approval of the Purchaser. All such products and equipment shall be used or installed in strict accordance with original manufacturer's recommendations, unless otherwise directed by the Purchaser.

10.12 Drawings and Documents

The Contractor shall supply all drawings and documents to the Purchaser/Consultants as per respective volumes of Technical Specifications.

10.13 Errors and Omissions

1. The Contractor shall be responsible for any discrepancies, errors and omissions in the drawings, documents or other information submitted by him, irrespective of whether these have been approved, reviewed or otherwise accepted by the Purchaser or not.
2. The Contractor shall take all corrective measures arising out of discrepancies, errors and omissions in drawings and other information referred in above para within the time schedule and without extra cost to the Purchaser.
3. The Contractor shall also be responsible for any extra cost and the cost due to delay, if any, in carrying out engineering and site works by other agencies arising out of discrepancies, errors and omissions stated above as well as of any late revision/s of drawings and information submitted by the Contractor.

10.14 Acceptance of the System

10.14.1 Mechanical Completion

1. On completion of erection of all the materials / items of equipment covered under the scope of the Contract, a joint inspection shall be carried out by the Purchaser and the Contractor to verify physically that all materials /items / equipment have been placed and erected properly and the system is ready for commissioning. A defects list shall be prepared jointly.
2. On liquidation of the defects (except minor defects which shall be mutually discussed and agreed between the Purchaser and Contractor and which shall not affect the commissioning of the system), Mechanical Completion Certificates shall be issued by the Purchaser.

10.14.2 Commissioning & PG Testing

1. Commissioning shall include preliminary operation, initial operation, and successful completion of trial operation.
2. Preliminary operation shall mean all activities after mechanical completion upto commencement of initial operation and shall include mechanical and electrical checkouts, calibration of instruments and protection devices, commissioning of sub/supporting system and static chemical cleaning of the Plant/System/Equipment covered under the Contract.
3. Initial operation shall mean all activities after completion of preliminary operation up to commencement of trial operation and shall be the integral operation of the complete System / Equipment covered under the Contract which shall include no-load / partial load / full load runs for mechanical/electrical try-out and gathering of operational data calibration setting and commissioning of control systems and shut-down inspection and adjustment after running trial of the System / Equipment covered under the Contract.
4. The initial operations Shall include operation of unit as a whole under normal operating conditions on plant automation system for twenty four (24) consecutive hours at the 100% TGMCR load or twelve (12) consecutive hours for two (2) consecutive days at the 100% TGMCR load unless otherwise agreed to by the Purchaser /Consultant or restricted by system load conditions.
5. After initial operation the Contractor has to intimate the Purchaser in writing regarding the readiness of the system for trial operation at least one week before commencement of trial operations. However, Contractor has to furnish sufficient records/documents to satisfy the Purchaser that all the equipment including services, auto loops and instrumentations are tested and ready for trial operations.
6. After the initial operations, the plant shall be on trial operation. During the trial operation, the Contractor shall be allowed to make minor adjustments as may be necessary, provided that such adjustments do not interfere with or prevent the commercial use of the plant or result in significant reduction of output or increase of the heat rate of the plant. For the period of trial operation the time of actual operation shall be counted.

The plant shall be under 'Trial operation' by the contractor for a period of 30 days, during which it shall be operated continuously/ intermittently at any unit load up to maximum capacity of 500 MW as desired by the purchaser. The trial operation will also include 72 hours of continuous operation on full load for the entire system. The maximum number of interruption attributable to CONTRACTOR will be four (4) numbers each not exceeding four (4) hours duration. In case within first four days of reliability operation either the number of interruptions, attributable to the CONTRACTOR exceeds four (4) or the duration of any of the four (4) interruptions exceeds four (4) hours, the Trial Operation will be repeated. Beyond four days, the Trial Operation will be extended for the corresponding period of interruptions of more than eight hours. After a cumulative 30 days of safe, stable Trial Operation, the Steam Generators will be Provisionally Taken Over by the Purchaser. The period of trial operation may be reduced, if so, as desired by the Purchaser. During trial operation, the contractor shall post sufficient number of qualified personnel.

The onus of proving that any failure is not due to faulty design, materials and workmanship shall lie with the Contractor

7. A 'trial operation' report comprising observations and recordings of various parameters measured in respect of the 'reliability operation' shall be prepared and submitted to the Purchaser /Consultant. This report, besides recording the details of various observations during 'trial operation' shall also include the dates of start and finish of the trial operation and shall be signed by the representatives of both the parties. The report shall have recordings of all details of interruptions that occurred, adjustments made and any repairs done during the 'trial operation'. The 'trial operation' shall be considered successful, provided that each item of plant can meet the above requirements.

8. On successful completion of trial operation, the unit shall be Provisionally Taken over with a list of major and minor defects and non conformities prepared jointly by the Purchaser and the Contractor. Differentiation of defects as major and minor shall be jointly discussed and agreed by the Purchaser and Contractor and recorded. Upon the completion of ' trial operation', as soon as practicable, or at such time as may be otherwise agreed to by the parties concerned, the Contractor Shall notify in writing to the Purchaser /Consultant that the plant is ready for performance tests only after liquidating all the major defects.

9. Readiness for "Performance Test" shall be intimated to the Purchaser in writing at least 15 days before commencement of "Performance Test". However, Contractor shall be allowed to conduct "Performance Test" only after liquidating all the major defects.

10. The performance tests shall be conducted at site for each unit and all major systems by the Contractor. The Contractor's commissioning Engineers Shall make the plant ready for such tests and assist the Purchaser in operation during the tests. The test shall be commenced after the 'Plant / Equipment' has attained stable operation The date of commencement of the performance tests shall be after completing trial operation and after attending all the

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pending works if any and major/minor defects or as may be mutually agreed upon between the Contractor and Purchaser. The defects / non-completion of work which will directly affect the power generation, performance / safety of the equipment, safety of the personnel will be included under major defect / major work and the other will be included in the minor defect / minor work. The performance test shall be conducted before the end of the third month from the date of completion of trial operation. The tests shall be binding on both the parties of the 'Contract' to determine compliance of the 'Plant' / 'Equipment' with the performance guarantees. The purpose of the performance tests is not only to check whether the plant meets the guaranteed performances but also provide a full mass, heat and energy balance for the whole plant which shall serve as reference to evaluate the plant performance in future over the plant life.

11. Performance Guarantee Test of each Steam Generator required to be conducted within three months from the date of "Provisional Take Over" of respective Steam Generator. In case the Performance Test is conducted beyond three months for reasons attributable to the Contractor, ageing factor shall not be considered during "Performance Test". However, the contractor has to complete the performance guarantee test within one year from the date of provisional take over, failing which, it shall be construed that the guaranteed performance has not been met and liquidated damages for shortfall in performance shall apply in full subject to the condition that delay in carrying out performance guarantee test is attributable to the contractor. However, the purchaser shall retain the option to reject the equipment, if necessary. Results of the Performance Test shall be submitted within 15 days of completion of performance test to the Purchaser for review and approval. The approval shall be given within 30 days of submission of results.

12. The performance test procedure, including the definition of the calculation method to be used, the instrumentation to be installed and indicated in the schemes, the instrument accuracy classes, the areas of responsibility and the items which specifically require preparation and agreement Shall be submitted by the Contractor for review and approval by the Purchaser /Consultant during detail engineering phase. Schematics identifying the guarantee test instrumentation shall be submitted along with procedure. It shall be ensured that necessary test points and spool pieces are indicated in the schemes during the detail engineering phase and also identified in process and instrumentation drawings. Contractor shall furnish detail program during detail engineering stage.

13. The performance test instruments shall be of precision type with instrument accuracy limits as required and defined in the applicable performance test codes such that measurement uncertainty does not exceed the values agreed to by the Contractor in the Schedule of Performance Guarantees. The performance tests shall be carried out as per test codes agreed in schedule of performance guarantees.

14. All test instrumentation for the performance tests as required shall be supplied by the Contractor on loan basis. Data loggers on loan basis shall be used extensively for SG tests. All costs associated with the supply,

calibration, installation and return of the test instrumentation / data loggers / computers etc. are deemed to have been included in the contract price. The test shall be in accordance with those specified or as per agreed performance test codes. Batch calibration shall not be accepted.

15. Any special equipment, tools and tackles required for successful completion of the performance tests shall be provided by the Contractor.

16. It is the Contractor's responsibility to co-ordinate for suitably carrying out the performance tests. The duration of the test wherever not indicated shall be in accordance with the agreed test codes at the loads after necessary stabilising period to obtain steady state conditions. All other tests to prove the guarantees as indicated in the Contract shall also be conducted.

17. The plant parameters during the performance test shall be adjusted as far as practicable to the guaranteed performance test conditions. The tests shall be conducted to prove guaranteed parameters as defined in the specification.

18. The performance test results shall be reported as computed from the performance test observations with corrections for site conditions, variations in fuel, etc. and test conditions. Such correction curves shall be finalised during Detail Engineering at least six (6) months before start of PG test. No additional allowances for errors in measurement are permissible.

19. Within 4 (four) weeks after the conclusion of the performance test and unit characteristics tests, the Contractor shall submit a test report to the Purchaser with a copy submitted to the Consultant stating:

    (a). In the case of a performance test, whether the unit passed or failed such test, accompanied by sufficient test data and calculations to demonstrate the level of performance attained with respect to each of the tested parameters.

    (b). In case of a unit characteristics tests, the level of performance achieved with respect to the desired levels of performance.

    The report(s) shall include as a minimum, the following:

    (i). Description of the test procedures
    (ii). Standards that were used
    (iii). Instrumentation details and calibration
    (iv). Full schematic diagrams with indication of instrument test location and identification tag of same.
    (v). Test logs and summary of test readings used for performance calculations
    (vi). Full set of correction curves
    (vii). Computation of test results.
    (viii). Conclusions of performance tests : test passed or not

20. Within thirty (30) days of receipt such test report(s), the Purchaser shall submit a notice to the Contractor with a copy submitted to the Consultant, stating either:

    (i). That Purchaser concurs with the information provided in the Contractor's test report(s), or

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(ii). That Purchaser disputes some or all of the information provided in the Contractor's test report(s), the areas being disputed, and the levels of performance being disputed.

21. If Purchaser disputes any or all of the results contained in the Contractor's test report(s), representatives of the Contractor, Purchaser and the Consultant shall meet after the receipt of the Purchaser's notice at a mutually acceptable date & location to review and discuss the dispute.

22. In relation to each unit, the Contractor shall give to the Consultant and Purchaser 21 (twenty one) days' notice of the date after which he shall be ready to make the tests and the Contractor shall commence the tests promptly thereafter. Any data obtained in respect auxiliary power consumption prior to the commencement of the Tests in relation to the Performance Guarantees shall not be used to assess whether the Performance Guarantees have been attained.

23. If the tests could be carried out but are being unduly delayed by the Contractor the Purchaser may, by notice require the Contractor to make the tests within 14 days after the receipt of such notice. The Contractor shall make the tests on such days within that period as the Contractor may fix and of which he shall give notice to the Purchaser.

24. If the Contractor fails to make the tests within 21 (twenty one) days of such notice the Purchaser may himself proceed with the tests. All tests so made by the Purchaser shall be at the risk and cost of the Contractor and the cost thereof shall be deducted from the contract price or charged to the Contractor. The tests shall then be deemed to have been made by the Contractor.

25. If any unit fails to pass the test (which in the case of performance tests means not achieving the acceptable limits), the Purchaser may require/allow such tests to be repeated on the same terms and conditions save that only reasonable notice of the date and time of such tests shall be required to be given by the Contractor to the Purchaser.

26. If the Purchaser /Consultant and the Contractor disagree on the interpretation of the test results, each shall give a statement of his views to the other within 14 (fourteen) days after such disagreement arises. The statement shall be accompanied by all relevant evidence. If Purchaser disputes any or all of the results contained in the Contractor's test report(s), representatives of the Contractor, Purchaser and the Consultant shall meet after the receipt of the Purchaser's notice at a mutually acceptable date & location to review and discuss the dispute. Mutual discussions will be held and agreed to determine the interpretation of the test results.

27. On successful completion of Commissioning & PG testing of the system as described above and on completion of entire Supplies including spares and new set of tools and tackles as per the Contract, the Commissioning Certificate shall be issued by the Purchaser.

10.14.3 Final Take Over

1. After successful completion of Performance Test of the unit(s), the Steam Generators shall be taken over and the guarantee period starts from this date of Final Take Over.
2. Till the 'Final Take Over' the Contractor shall provide qualified personnel to guide the Purchaser's personnel.
3. Any non-conformity arising in the system and any rectification in the dismantling works till 'Final Take Over' shall be rectified by the Contractor at his own cost Purchaser shall not be held responsible for any such non-conformities arising during this period.
4. Purchaser reserves the right to declare the commencement of commercial operation at his discretion on any day after successful completion of trial operation. The Contractor shall not be absolved of his responsibilities for the reason being the commercial operation has started.
5. In case any stoppages are required for repairing/ replacing the parts of the system by the Contractor, the Purchaser shall release the system for such repairs/ replacement within a reasonable time.
6. Certificate for "Final Take Over" shall be issued by the Purchaser when
   (a) All supplies and services have been completed as per Contract.
   (b) The Contractor has met any and all obligations under this Contract.
   (c) Final balance documentation, if any, incorporating latest modifications in 'as built' drawings has been submitted by the Contractor in requisite copies.
   (d) The Contractor has rectified in a definite manner all objections / observations mentioned in the "Commissioning Certificate" and 'Final Project Punch List'

10.15 Mandatory Spares, Tools & Tackles and Consumables

10.15.1 Mandatory Spares: Intentionally deleted.

10.15.2 Tools and Tackles: Intentionally deleted.

10.15.3 Initial Fill, Oil, Lubricants & Consumables: Intentionally deleted

10.16 Approval by the Purchaser

1. Documents and drawings as mentioned in Schedule-4 shall be subject to the approval of the Purchaser/ Consultant.
2. Other drawings and documents as per Schedule-4 shall be subject to the review and reference of the Purchaser/ Consultant.
3. All changes from the approved drawings/documents shall be subject to the prior approval of the Purchaser / Consultant.
4. All sub-contractors and sub-suppliers for raw materials testing, design and engineering, manufacture, supplies, construction and erection work and any other work/services covered under the Contract shall be subject to the written approval of the Purchaser / Consultant.
5. While the Contractor shall make/execute/perform supplies, work and services in terms of the Contract, the Purchaser shall have the right to check and

approve design, type, quality, quantity, materials and workmanship of any or all items of supplies, work and services where considered necessary by the Purchaser to ensure that supplies, work and services made/executed/ performed by the Contractor are in accordance with the provisions of this Contract.

6. The Chief Project Manager of Contractor who shall be in overall charge of the Project at site shall be appointed in consultation with the Purchaser.
7. Detailed assignment schedules of foreign Experts/ Specialist for rendering technical services shall be submitted by the Contractor for the approval of the Purchaser within six months from the date of LOA. The bio-data of key personnel shall be submitted within two months of the date of LOA and for others six months before their deputation.
8. To enable the Purchaser to accord approval and to review documents and drawings the Contractor shall submit back-up data/ drawings/basic calculations/assumptions as may be required by the Purchaser/ Consultant.
9. Where approval of the Purchaser/Consultant is required or implied but is not specifically provided for elsewhere in this Contract, such approval shall also come within the purview of this schedule.
10. Approval by the Purchaser/Consultant in terms of this schedule shall not relieve the Contractor of any of his obligations under the Contract. The Purchaser/ Consultant shall approve within 30 (thirty) days or refuse approval within 15 (fifteen) days from the date of receipt of request with supporting documents.
11. The approval requested by the Contractor shall not be withheld unreasonably by the purchaser. All requests for approval shall be accompanied by fully supporting documents, otherwise it shall not be considered as a request.

10.17 Sub-Contract

1. The Contractor shall not sub-contract the Contract Work in whole to third parties for the performance of this Contract.
2. The Contractor may propose a panel of Sub- Contractors for the part of scope of works. The Contractor shall thereafter select any sub-Contractor out of this panel subject to the approval of the Purchaser. Any such assignment shall not relieve the Contractor from any obligation, duty or responsibility under the contract. Any assignment as above without the prior concurrence of the Purchaser shall be void.
3. The Contractor shall be responsible for transmitting all the pertinent data of all Contract terms and conditions with his Sub-Contractors. The Contractor shall also furnish the specification, place of manufacture, delivery schedule and adequate, unpriced copies of supply orders/contract he has entered into in respect of imported items and adequate copies of un-priced supply order/contract in the case of indigenous items.
4. The Purchaser shall give approval or shall refuse approval in writing within 30 days of receipt of request along with all supporting details.
5. Bought-out items, critical components, proprietary items and equipment manufactured and supplied by specialised manufacturers which the

Contractor intends to incorporate in the Contract Work shall also be subject to the written approval of Purchaser

6. The approval extended by the Purchaser in selecting Sub-Contractors recommended by the Contractor shall not discharge the later from his Contract obligations. The Contractor shall remain solely liable for any action, deficiency, and/or negligence on the part of his Sub-Contractors/sub-suppliers.
7. In the event certain obligations extended by a Sub-Contractor to the Contractor should extend beyond the guarantee period specified in the Contract, the Purchaser shall automatically be entitled to the benefit thereof.
8. In no event shall the Purchaser be deemed to have any Contractual obligations whatsoever in respect of Contractor's/ Sub-Contractors and/or title-holders of any sub-orders placed by the Contractor.

10.18 Inspection and Tests at Contractor's/ Manufacturer's Premises

1. The Purchaser or his authorised agent shall have the right of inspecting and testing the contract work or any part thereof at any stage during the manufacture and the Contractor on demand from the Purchaser shall carry out such tests in appropriate manner in the presence and free of charge to Purchaser. The tests required as per relevant codes and the tests specifically agreed in the contract specifications and agreed QAP only will be done. Should the Contractor himself not be in a position to carry out the tests, he shall, on the Purchaser's demand prepare specimen and samples and send them at his own cost to such testing stations as the Purchaser may specify and the cost of the test so effected shall be to the Contractor's account. However, cost pertaining to the Purchaser's inspection personnel shall be borne by the Purchaser.
   (i). Should a part of the plant be manufactured not on Contractor's own premises but on other premises, the Contractor shall likewise obtain permission for the Purchaser/his authorised representative to inspect and test the work as if the said plant were being manufactured on the Contractor's premises.
   (ii). The inspection, examination or testing carried out by the Purchaser shall not relieve the Contractor from any of his obligations under this Contract. The inspection procedure shall be discussed and finalised.
2. The inspection and tests shall be so conducted as not to unreasonably impede the progress of manufacture.
3. The Purchaser shall have the right to be present during all tests carried out by the Contractor. The Contractor on being requested so to act, shall present sufficient documentary evidence that the material used shall meet the specified requirement. If called for, samples and specimen shall become the Purchaser's property. The Contractor shall notify the contract work, particularly before any assembly, in order that the inspection or tests can be carried out as may be required to ascertain without prejudice to the Contractor's liability, whether the materials and/or services are in conformity with the requirement of the contract. All inspection and tests shall be carried out as per the approved procedure unless otherwise specified.

4. The Contractor shall bear all costs of any and all agreed inspections and tests. If special tests are necessary based on the results of the agreed test, then cost of all such special tests also shall be to the account of the Contractor in all cases.

5. The Purchaser upon giving 15 (fifteen) days notice in writing and stating any grounds of objection, shall have the right to reject any or all equipment or demand rectification or replacement thereof.

6. The Contractor shall submit to the Purchaser quarterly programme of inspection and tests one month in advance of the commencement of the quarter. The Contractor shall give the Purchaser a minimum of 15 (fifteen) days clear notice for inspection within India and 30 (thirty) days clear notice for inspection at places other than India, of any work being ready for inspection and tests specifying the period likely to be required for such inspection and tests. Thereafter, the Purchaser or his inspector shall, unless inspection or test is voluntarily waived, attend at the contractor's or his Sub-supplier(s)/Sub-contractor(s) premises, such inspection and tests within 7 (seven) days of the date on which the equipment is notified as being ready for inspection and test. Should the Purchaser fail to attend such inspection and test, the Contractor may proceed with the inspection and test at his option which shall be deemed to have been made in the Purchaser's presence and shall forthwith forward to the Purchaser copies of inspection/test certificates for acceptance by the Purchaser. The pro-forma and number of copies for inspection/test certificates shall be mutually agreed. However, if the Purchaser request the Contractor for a revised date of inspection but within 15 days of the date of inspection as communicated by the Contractor, the Contractor shall arrange the inspection on the revised date as requested by the Purchaser.

7. In all cases whether at the premises or works of the Contractor or of any sub-contractor, the Contractor shall, provide free of charge to the Purchaser such labour, materials, electricity, fuel, water, stores, apparatus and instrument and/or facilities as may reasonably be deemed required to carry out efficiently such tests of the plant in accordance with the contract and shall give all such facilities to the Purchaser or his authorised representative to accomplish such tests.

8. When the inspection/tests have been satisfactorily completed at the Contractor's or his Sub- Contractor's premises, the Purchaser shall issue a certificate to that effect. If a final certificate can not be issued, a provisional certificate shall be issued. If the tests were not witnessed by the Purchaser or his representative the certificate shall be issued on receipt of the inspection and tests report from the contractor but not later than 15 (fifteen) days after the receipt of the said report by the Purchaser. In the event a certificate is not issued by the Purchaser during 15 (fifteen) days, the Contractor, if considered necessary, can arrange despatch along with the certificate as stated in 10.18.6 with the clear understanding that if the Purchaser reject such equipment at a later date, the contractor shall rectify the same at his own cost to the Purchaser's satisfaction. No Plant shall be shipped or left or otherwise despatched before such certificate has been

issued. The satisfactory completion of these inspection and tests or the issue of the certificate shall not bind the Purchaser to accept the work, should it on further tests during or after erection be found not to comply with the Contract.

9. In case any equipment fails in inspection/tests, re-inspection/retest shall be carried out only after necessary rectification work/replacement by the Contractor.

10. Subject to Clause-10.18.8 above, no plant, equipment and material shall be shipped before inspection certificate and despatch instructions have been issued by the Purchaser.

11. The contractor shall furnish to the Purchaser/his authorised Inspector five (5) copies of un-priced purchase orders including detailed technical specification and drawings placed on his Sub- Contractors as soon as such orders are placed by the Contractor, but in any case not later than two (2) months before the expected date of the equipment getting ready for inspection.

12. In the case of mandatory spares and recommended spares, the same shall be offered for inspection along with the main equipment or after the main equipment has been satisfactorily inspected and tested.

13. In the case of such equipment, structural etc. where tests set forth above cannot be conducted either partially or fully in Contractor's/Sub-supplier(s) premises but have to be conducted at site only after erection, the provisions under this schedule shall also apply. However, in such cases prior approval of the Purchaser shall be obtained by the Contractor prior to despatch.

10.19 Participation of Indian Engineers

1. For basic design and detail engineering of Plant & Equipment, if carried out by the Contractor in his office abroad, Purchaser reserves the right to depute his/Consultants' or engineers hereafter called Indian Engineers to participate in this work.

2. The participation assignment, number of Indian engineers, their technical disciplines and the period of participation shall be mutually agreed.

3. The Contractor shall provide all opportunities and information to Indian engineers to get acquainted with the technical know-how and the methods and practices adopted by the Contractor in basic and detail engineering. The Contractor shall provide documents, drawings, calculations etc. as may be required by Indian engineers.

4. The Contractor shall provide free of charge office accommodation, office facilities, secretarial services, communication facilities, general and drawing office stationary, etc as may be reasonably required by the Indian engineers. Similarly, facilities shall also be provided by Contractor's /Sub-Contractors/ Associates if such basic and detail engineering activities are carried out in the design offices of Sub-Contractors/Associates.

5. At all times the Indian engineers shall remain employees of the Purchaser or Consultant as the case may be.

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6. The Purchaser shall bear all costs relating to air fares, local travel, residential accommodation and subsistence in respect of Indian engineers.

7. In the absence of designation as Purchaser's or Consultants' representative, no such Indian engineer shall have any authority under the Contract.

10.20 Standards, Codes and Compliance with Laws & Regulations

1. The design, engineering, manufacturing, supplying, assembling, erection, testing and construction work shall be carried out in accordance with latest appropriate Indian Standards and Codes unless otherwise specified in the Contract specification. Where appropriate Indian Standards and Codes are not available, appropriate latest standards and codes of Country of Origin shall be used. Contractor shall however, obtain purchaser's prior approval before using such standards and codes of country of origin.

2. The Contract Work shall be designed to suit the climatic, geological, hydrological, hydro-geological, and seismological and soil conditions of the site. Measures shall be taken against corrosion/erosion by ground water, storm surge, floods, cyclones, wind speeds etc.

3. The Contractor shall, throughout the performance of this Contract comply with all laws, rules, regulations and statutory requirements of Government of India, Government of Tamil Nadu and other statutory bodies as far as such bodies have jurisdiction over the Contract work or any part of the site.

4. If any new statutory regulation or law or modification of the existing regulation or law comes into force subsequent to the Base Date, the Contractor shall comply with the same. However, if it calls for any modification of the design/equipment with financial implication, the same shall be discussed between the Contractor and Purchaser and mutually agreed.

10.21 Protective Painting

The General Specification for painting and colour code etc shall be followed by the Contractor for painting of equipment, steel structures etc. as per the technical specification.

10.22 Weights & Measures

1. All weights, dimensions and measures shall be in metric system.

2. All weights, instruments, measures used in the contracted equipment shall be properly calibrated.

10.23 Secrecy, Titles

1. All maps, plans, drawings, specifications, schemes and the subject matter contained therein and all other information given to the Contractor by the Purchaser in connection with the performance of the Contract Work shall be held confidential by the Contractor and shall remain the property of the Purchaser and shall not be used or disclosed to third parties by the Contractor for any purpose other than for which they have been supplied or prepared. The Contractor may disclose to third parties, upon execution of secrecy agreements, such part of the drawings, Specifications or information if such disclosure is necessary for the performance of the Work.

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2. Maps, layouts and photographs of the unit/integrated Thermal Power Station including its surrounding regions showing vital installation for national security of Purchaser's country shall not be published or disclosed to the third parties or taken out of the country without prior written approval of the Purchaser.

3. Title to secret processes if any developed by the Contractor on an exclusive basis and employed in the design of the equipment shall remain with the Contractor. The purchaser shall hold in confidence such processes and shall not disclose such processes to the third parties without prior approval of the Contractor.

4. Subject to above Clause, title to technical specifications, drawings, flow sheets, norms, calculations, diagrams, interpretations of test results, schematics, lay-outs and such other information which the Contractor has supplied to the Purchaser under the Contract shall be passed on to the Purchaser. The Purchaser shall have the right to use these for construction, erection, start-up, commissioning, operation, maintenance, modifications and/or expansion of the works including for the manufacture of spare parts in connection with the project.

5. The provision of above Clauses shall not apply to information:

   (i). Which at the time of disclosure are in the public domain or which later on become part of public domain through no fault of the party concerned, or

   (ii). Which were in the possession of the party concerned prior to disclosure to him by the other party, or

   (iii). Which were received by the party concerned after the time of disclosure without restriction on disclosure or use, from a third party.

10.24 Rejection of Defective Plant & Works or Other Installation

1. If the completed plant, or any portion thereof, before it is finally accepted be found to be defective or fails to fulfil the requirements of the Contract, the Purchaser shall give the Contractor notice setting forth particular of such defects or failure and the Contractor shall forthwith make the defective plant good, or alter the same to make it comply with the requirements of the Contract. Should he fail to do so within a period of time as deemed reasonable by the Purchaser and stated in the said notice, the Purchaser may reject and replace at the risk and cost of the Contractor, the whole or any portion of the plant, as the case may be, which is defective or fails to fulfil the requirements of the Contract. However, such rejection/replacement by the Purchaser shall not absolve the Contractor of any of his responsibilities under this Contract.

2. Without prejudice to the above, the Purchaser shall be entitled at his discretion to the use of the rejected plant in a reasonable and proper manner for a time reasonably sufficient to enable him to obtain other replacement plant. However, such usage shall not be deemed as waiver or acceptance of such defective plant by the Purchaser.

10.25 Negligence

1. If the Contractor shall neglect to execute work with due diligence or expedition or shall refuse or neglect to comply with any reasonable order given to him in writing by the Purchaser in connection with the work or shall contravene the provisions of Contract, the Purchaser may give notice in writing to the Contractor calling upon him to make good the failure, neglect or contravention complained of within such time as may be deemed reasonable by the Purchaser and in default of compliance with the said notice, the Purchaser without prejudice to its rights under clauses 10.25 (2) hereto and Cl. 6.6.9, may rescind or cancel the Contract as provided in Cl.10.30 holding the Contractor fully liable for the damages that the Purchaser may sustain. In addition, the Contractor shall refund all amounts paid to him by the Purchaser for all such work which, may become infructuous due to such cancellation.
2. Should the Contractor fail to comply with such notice within the period as mentioned in the notice or any other period considered reasonable by the Purchaser for such compliance, from the date of serving thereof, then and in such case, without prejudice to the Purchaser's right under clause 10.25.1 hereto, the Purchaser shall have at his option the right to take the affected work wholly or in part out of the Contractor's hands and may complete the work, as envisaged in the Contract either departmentally or by awarding fresh Contract(s) at a reasonable price to any other persons or firm or company to execute the same, at the cost of the Contractor.
3. In such event the Purchaser shall, without being responsible to the Contractor for fair wear and tear to the same, be entitled to seize and take possession of all materials, construction equipment tools, tackles and other things belonging to the Contractor and also to have free use of all materials, construction equipment, tools, tackles and other things of the Contractor / its sub-contractors which may be on the site for use at anytime in connection with the work to the exclusion of any right of the Contractor over the same and the Purchaser shall be entitled to retain and apply any sum which may otherwise be then due as per the Contract or any other contract from him to the Contractor as may be necessary for the payment of the cost of execution of such work as aforesaid.
4. If the cost of executing the work as aforesaid shall exceed the sum due to the Contractor and the Contractor fails to make good the deficit, the said materials, tools, tackles, construction plant or other things and properties belonging to the Contractor as may not have been used up in the completion of the work, may be sold by the Purchaser and proceeds applied towards the payment of such difference and the cost of and incidental to such sale. Any outstanding balance existing after crediting the proceeds of such sale shall be paid by the Contractor on the demand of the Purchaser, but when all expenses, cost and charges incurred in the completion of the work are paid by the Contractor, all such materials, tools, tackle, construction plant or other things not used in the completion of the work and remaining unsold shall be removed by the Contractor with the written permission of the Purchaser only.

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5. In addition, such action by the purchaser as aforesaid shall not relieve the contractor of his liability to pay LD. for delay in completion of work as defined in Schedule-4.

10.26 Progress Report

1. The Contractor shall prepare and regularly update his detailed PERT/CPM Networks and submit the same with computerized time analysis reports showing starting and completion dates of all activities of engineering, purchasing, procurement of materials, manufacture, supply, inspection and despatch, construction, erection etc. in his scope of work and those of his sub-contractor(s).
2. The Contractor shall submit the progress report in such pro-forma and details as may be required by the Purchaser showing the agreed detailed programme of various activities as per above clauses and actual progress achieved to monitor the progress of the work.
3. The Contractor shall submit the progress report every month and in 15 (fifteen) copies. Purchaser shall have the right to depute his/Consultant's representatives at the premises of works of the Contractor or any of his sub-contractors to ascertain the progress of work.
4. The Contractor shall submit the progress photographs in 10 (ten) copies every month relating to the progress in sequence of work of all major activities.

10.27 Training

1. While basic induction training for all categories of staff and for all job positions shall be provided by the Purchaser, the Contractor shall identify from the manpower requirements, the key positions and number of persons to be trained for efficient running of the plant. Purchaser shall depute personnel with appropriate qualifications and experience for training.
2. The Contractor shall arrange for training of Purchaser's personnel for working procedures and systems covering working norms and quality standards. Such training shall include training in Contractor's design and engineering department and/or in the manufacturer's shop and for operation and maintenance in working plants.
3. The Contractor shall give detailed training programme for Purchaser's personnel, well in advance of their arrival at the place of training. The training programme can be changed by mutual agreement of the parties hereto depending on the requirement. The Contractor shall supply (1 microfilm and 5 copies) all Training Manuals, Instructions and other connected literature in 6 copies to the Purchaser in English Language.
4. In addition, each trainee shall also receive a complete set of such Training Manuals, Instructions and other connected literature.
5. For maintenance personnel earmarked for training with the Contractor, it must be ensured that they are associated during preparation and testing of major assemblies/sub-assemblies at manufacturer's works.
6. The period and the nature of training for the individual shall be agreed upon mutually between the Contractor and the Purchaser. These engineering

personnel shall be given special training in the shops, where the equipment shall be manufactured and/or in their collaborator's works and where possible, in any other plant where equipment manufactured by the Contractor or his collaborator is under installation or test, to enable those personnel to become familiar with the equipment being furnished by the Contractor.

7. All travelling and living expenses for the engineering personnel of the Purchaser to be trained during the total period of training shall be borne by the Purchaser. The Contractor shall, however, arrange for necessary accommodation and other local and transport facilities free of cost, at the site of training/ manufacturing works for the trainees. However contractor will arrange free accommodation at his manufacturing units subject to availability. These engineering personnel while undergoing training shall be responsible to the Contractor for general discipline. For non-utilization of offered training period, no rebate will be applicable.

10.28 Patents

1. If the performance of the Contract involves the use of a patent, trade mark, registered design, copy rights and/or industrial property rights of which the Contractor holds the title, the Contractor shall not be entitled to any licence fee, royalty and/or compensation from the Purchaser outside of the Contract Price which shall be deemed to include such licence fee, royalty and/or compensation.

2. Where the title holder of a patent, trade mark, registered design, copy rights and/or industrial property rights used is a third party, the Contractor shall be liable for settling with such party and paying any licence fee, royalty and/or compensation thereon.

3. The Contractor shall submit to the Purchaser a certificate from the licensor attesting technology of the licence granted.

4. In the event of any third party raising claim or bringing action against the Purchaser including but not limited to action for injunction in connection with third party's alleged rights affecting the equipment covered under the Contract or the use thereof, the Contractor agrees and undertakes:

   (i). To defend and assist the Purchaser in defending at the Contractor's cost against such third party's claim and/or actions and against any law suits of any kind initiated against the Purchaser.

   (ii). To indemnify, keep indemnified and hold harmless the Purchaser against all actions, claims, demands, costs, charges and expenses raised by third parties and arising from or incurred by reason of any infringement of patent, trade mark, registered design, copy rights and/or industrial property rights by manufacture, sale or use of the equipment supplied by the Contractor whether or not the Purchaser is held liable for by any court judgement. Provided, however, that:

      (a) The Purchaser shall, as soon as reasonably possible notify the Contractor in writing of such third party's claim and/or action and:

- The Contractor shall at his own cost defend or assist the Purchaser in defending his rights against any such claims and/or actions ;
- If the Contractor defends the case, the Purchaser shall assist the Contractor free of charge by providing all such information and documents as are available with the Purchaser, save and except that in case of production of any witness at the request or insistence of the Contractor shall bear the costs and expenses required in this regard.

(b) The Purchaser shall not without the Contractor's consent (which shall not be unreasonably withheld) enter into any commitment or admit any fact capable of supporting third party's claims, unless the Purchaser shall release the Contractor of his liabilities and obligations.

(c) The Contractor shall at his own cost, without prejudice to the provisions of this Schedule, may either carry out such alterations or modifications of the equipment which are necessary to avoid the infringement without affecting the efficient operation of the equipment to the satisfaction of the Purchaser or to procure a right to the unrestricted use of the infringing equipment by the Purchaser.

5. Nothing in this article shall abrogate or abridge the Contractor's own liability for infringement or violation of patent, trade mark, registered design, copy rights and/or industrial property right of a third party, if such infringement or violation is proved before and sustained in court of law and the Contractor fails to take action in terms of provision of Clause 10.28 (4)

6. If required and mutually agreed, the Purchaser shall enter into Process Licence Contract(s) as per clause 10.28. (2).

7. The rights and liabilities of the parties under this Clause shall survive this Contract.

10.29 Indemnity

1. The Contractor shall at all times indemnify and keep indemnified the Purchaser against all claims which may be made against the Purchaser in respect of any infringement of any rights protected by patent registration of design of trade mark. In this connection, the Purchaser shall pass on all claims made against him to the Contractor for settlement.

2. The Contractor assumes responsibility for and shall indemnify and save harmless the Purchaser from all liability, claims, costs, expenses, taxes and assessments including penalties, punitive damages, attorney's fees and court costs which are or may be required to be paid by the Purchaser arising from any breach of the Contractor's obligations under the Contract or for which the Contractor has assumed responsibilities under the Contract including those imposed under any Contract local or national law or laws, or in respect to all salaries, wages or other compensation or all persons employed by the Contractor or his Sub-Contractors or suppliers in connection with the performance of any work covered by the Contract. The Contractor shall execute, deliver and shall cause his Sub-contractor and suppliers to execute

and deliver, such other further instruments and to comply with all the requirements of such laws and regulation as may be necessary there under to conform and effectuate the Contract and to protect the Purchaser.

3. The Purchaser shall not be held responsible for any accident or damages incurred or claims arising there from during the period of construction and erection under the responsibility of the Contractor/sub-contractors/associates and putting into operation of the plant under the supervision of the Contractor in so far as the latter is responsible. However, the Contractor shall be liable for such accidents as may be due to negligence on his part to carry out work in accordance with Indian laws and regulations.

4. The Contractor shall be responsible for proper fencing, lighting, guarding and watching of all works at site until they are taken over and further arrange proper provisions for like period of temporary drainage, roadways, footways, guards and fences as far as may be rendered necessary by reason of works for accommodation and protection of the Purchaser's adjacent property and that of, the public and others. No naked light shall be used by the Contractor on the site otherwise than in the open air without the special permission in writing from the Purchaser. The purchaser shall not be responsible for any theft or misuse of material/plant, equipment.

10.30 Termination, Suspension and Foreclosure

1. The Purchaser may at any time on breach of this Contract by the Contractor give him a written notice of such breach. If the Contractor does not take appropriate measure to the satisfaction of the Purchaser within a period of 30 days after issuance of such notice to remedy that breach, then the Purchaser may terminate this Contract at any time thereafter stating therein the date of termination. The Contractor shall then be liable to the Purchaser in accordance with the Clause- 10.25 hereinabove.

2. The Purchaser reserves the right to terminate this Contract at any time by giving a notice of not less than 30 (thirty) days without assigning any reason. The Contractor shall stop the performance of the Contract from the Date of termination and hand over all the drawings, documents, plant, equipment, supplies, material etc. including all the rights of work to the Purchaser. The Purchaser shall pay to the Contractor the cost incurred as decided by the Purchaser till the date of termination as compensation. No consequential damages shall be payable by the Purchaser to the Contractor in the event of termination.

   If the contract is terminated due to the default of the Contractor, the initial advance would be deemed as interest bearing advance at an interest rate prevailing as on the date of NIT to be compounded quarterly.

3. The Purchaser may suspend the work in whole or in part at any time by giving Contractor notice in writing to such effect stating the nature, the date and the anticipated duration of such suspension.

4. On receiving the notice of suspension as per above clause, the Contractor shall stop all such work which the Purchaser has directed to be suspended with immediate effect. The Contractor shall continue to perform other work in terms of the Contract which the Purchaser has not suspended.

5. The Purchaser may at anytime cancel the suspension notice for all or any part of suspended work by giving written notice to the Contractor specifying the part of work to be resumed and the effective date of suspension withdrawal. The Contractor shall resume the suspended work as expeditiously as possible after receipt of such withdrawal of suspension notice.
6. In the event of suspension of work, the Purchaser shall not be liable to the Contractor for any damage or loss or idle labour caused by such period of suspension of work. The Purchaser shall not be liable to Contractor for any payment towards watch & ward and any other expenditure

   However, the compensation for the suspension period beyond 60 days in aggregate, for the reasons attributable to the Purchaser, shall be mutually discussed and agreed. Further for the actual suspension period, for the reasons attributable to the Purchaser, which will affect the progress of Contractor's work and the scheduled completion time, the extension of time, shall be granted, on request from the Contractor.
7. The contract shall be terminated if due to any unforeseen circumstances which may lead to the foreclosure of the project for reasons such as resource crunch, non-availability of funds, and for other administrative resource etc. Purchaser shall however, give 60 days prior written notice to the contractor of the effective date of termination.
8. Contractor shall be compensated only for the quantum of work/services he has rendered till effective date of foreclosure. Any other claims like compensation for loss in profit, compensation for loss of reputation etc. or any other consequential damages if any claimed by the Contractor shall not be given by the Purchaser.

10.31 Termination of Services of Contractor's Personnel

In the event any of the Contractor or his Sub- Contractors, personnel, agents, sub-agents, assistants, or other employees shall be guilty of any misconduct or be incompetent or insufficiently qualified or negligent in the performance of their duties or it is undesirable for any administrative reasons for such person to be employed, the Contractor, if so directed, shall immediately remove such person or persons from employment thereon. Any person or persons so removed shall not again be employed in connection with this Contract without the written permission of the Purchaser. Any person so removed shall immediately be replaced by a qualified and competent substitute at the Contractor's cost and expenses. Should the Contractor be requested to repatriate any person he shall do so and shall bear all costs and charges in connection therewith.

10.32 Force Majeure

The following shall constitute Force Majeure:

1. Acts of God, acts of Government and other causes as strikes, lockout or other concerted action of workmen, war, sabotage, riots, civil commotion, police action, revolution, flood, fire, earthquake and epidemic. However power cut and Failure in water supply shall not be considered under Force Majeure conditions.

2. If the Contractor suffers delay in the due execution of the contractual obligations due to delays caused by Force Majeure as defined above, the agreed time of completion of the work covered by this contract and of the obligations of the Contractor shall be extended by a period of force majeure, provided, that on the occurrence of any such contingency, the Contractor immediately reports to the Purchaser in writing, the cause of delay with requisite documentary evidence and also the remedial steps being taken and the expected period of interruption.

   - However, as regards to the Sub-Contractors of the contractor, the events or occurrences enumerated above in Clause 10.32.(1) which are site-specific to Neyveli shall constitute force majeure events but excluding strikes, Lockouts or other concerted action of workmen of such subjects.

3. The decision of the Purchaser whether there is a Force Majeure condition or not and whether extension of time shall be granted or not shall be final.
4. Force Majeure conditions prevailing at the works of the Sub-Supplier(s) / Sub-Contractor(s) other than the following four (4) major sub-suppliers shall not be recognised by the Purchaser on any account and it shall be up to the Contractor to make necessary alternative arrangement to execute the Contract within the agreed time schedule.
   i) ALSTOM Boiler Deutschland GmbH, Stuttgart, Germany
   ii) ALSTOM India Ltd., Durgapur Works, West Bengal, India
   iii) ALSTOM India Ltd., Shahabad Works, Maharashtra, India
   iv) Tata Refractories, India
5. The contractor or the Purchaser shall not be liable for delays in performing his obligations resulting from any Force Majeure cause as referred to and/or defined above. The date of completion shall subject to hereinafter provided, be extended by a reasonable time even though such cause may occur after the contractor's performance of his obligations has been delayed for other causes.
6. If the performance of the contract is substantially prevented, hindered or delayed for a continuous period of more than 180 (one hundred eighty) days on account of one or more events of force majeure during the currency of the contract, then the Purchaser and Contractor shall discuss and agree upon for taking appropriate decision on future course of action.

10.33 Jurisdiction, Resolution of Disputes & Arbitration

10.33.1 Jurisdiction

The laws applicable to this Contract shall be the laws in force in India. The civil courts having ordinary original jurisdiction over Neyveli shall alone have exclusive jurisdiction over all matters concerning this Contract including the arbitration proceedings if any arising under the Contract.

10.33.2 Resolution of Disputes

Informal Dispute Resolution

1. The parties agree to use reasonable efforts to resolve all disputes equitably and in good faith. If any dispute between the Contractor and the Purchaser

arises it shall in the first instance be referred in writing to the Purchaser, who shall endeavour to resolve the dispute amicably and render a decision within 30 days. The period of 30 days shall be reckoned from the date of intimation of the dispute is received by the Purchaser.

2. Save as hereinafter provided, in respect of a dispute so referred, the decision of the Purchaser shall be final and binding upon the Parties until the completion of the Contract and shall forthwith be given effect to by the Contractor who shall proceed with the Contract with all due diligence, whether or not either Party has sought arbitration of the dispute as hereinafter provided.

10.33.3 Arbitration

In the event of any dispute or difference, relating to the interpretation and application of the provisions of the Contracts, such dispute or difference shall be referred by either party to the arbitration of one of the Arbitrators in the Department of Public Enterprises. The Arbitration and Conciliation Act, 1996 shall not be applicable to the arbitration under this clause. The award of the Arbitrator shall be binding upon the parties to the dispute, provided, however, any party aggrieved by such award may make a further reference for setting aside or revision of the award to the Law Secretary, Department of Legal Affairs, Ministry of Law & Justice, Government of India. Upon such reference the dispute shall be decided by the Law Secretary or the Special Secretary/Additional Secretary when so authorised by the Law Secretary, whose decision shall bind the parties finally and conclusively. The parties in the dispute shall share equally the cost of arbitration as intimated by the Arbitrator. The Procedure to be adopted in the case of arbitration is as per the Government's Circular dated 30.06.93 and its amendments, if any issued from time to time.

10.34 Warranty

1. The Contractor shall guarantee that the equipment shall be new and in accordance with the Contract documents and be free from defects in design, material and workmanship. The warranty period shall be 12 (twelve) months from the date of successful date of completion of Performance Guarantee Tests and acceptance of results by the Purchaser/Consultant for respective units. If the PG test is not performed within 12 months of provisional takeover, due to reasons not attributable to the Contractor, then warranty period shall start at the end of 12th month. In this case the PG test shall be conducted on a mutually agreed date. The Contractor's liabilities shall be limited to the replacement of any defective parts in the equipment of his own manufacture or those of his Sub-Contractors, under the normal use and arising from faulty design, materials and/or workmanship. The plant shall be operated as per the operating instructions and all records, log books and other information about the operation shall be kept. Such replaced defective parts shall be taken back by the Contractor. The Purchaser may however carry out maintenance as per O&M manual during the warrantee period as per accepted practices.
2. The Purchaser under the supervision of the Contractor's experts shall carry out complete operation of the plant after Provisional take over till completion of warranty period. However (i) All the maintenance works including repairs