THDC INDIA LIMITED

4X111 MW THDC VISHNUGAD PIPALKOTI HYDRO ELECTRIC PROJECT (HEP)

TECHNICAL SPECIFICATION

FOR

HVAC SYSTEM

SPECIFICATION NO.: - PE-TS-413-571-11000-A002 (REV00)
(MAR-2026)

BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
BHEL SADAN
SECTOR-16A, PLOT NO.-25, NOIDA, INDIA

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SECTION - I

SECTION-I

SUB-SECTION-A

INTENT OF SPECIFICATION

1.0 INTENT OF SPECIFICATION

1.1 The specification covers design (i.e. Preparation and submission of drawing /documents including "As Built" drawings and O&M manuals), engineering, manufacture, fabrication, assembly, supply / procurement, inspection and testing at vendor's / sub vendor's / manufacturer's works, painting, maintenance tools & tackles (as applicable), fill of lubricants & consumables till handing over, mandatory spares along with spares for erection, start-up and commissioning as required, forwarding, proper packing and shipment till storage area and delivery from storage area to site, unloading, handling & on-site transportation, storage, preservation , security / safety at site , Erection & Commissioning, final painting at site, minor civil work, trial run at site and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer / client O&M staff, Annual Maintenance Contract of HVAC system after commissioning till handing over and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification as specified above, amendment & agreements till placement of order for 4X111 MW VISHNUGAD PIPALKOTI HEP (HEP).

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 **HVAC 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 terms required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.

1.5 Storage space shall be provided within approximately 25 km from Power House area. Handling & on-site transportation from storage till site & equipment location (Power house area, Dam area, TRT area) is in bidder's scope.

1.6 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.

1.7 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.

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

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

1.10 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 – C1 shall prevail over section – D, however more stringent requirement as per the interpretation of the owner shall apply.

Further, in case of any discrepancy in section 'C1' and section 'C2', Section-C2 shall prevail (customer specification).

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

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

SECTION: I

SUB-SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA

3. Site and Other Data

(Data is based on Joshimath observatory)

1. CLIMATIC CONDITIONS :

1.1 TEMPERATURE DATA

i)	Temperature of Air in shade	(Ever recorded)
	(a) Maximum temp	31^0 C
	(b) Minimum temp	(-)2.9 ^{0} C
ii)	Maximum variation between day & night temperature during	
	(a) Winter	9.9 ^{0} C
	(b) Summer	11.6^0 C
iii)	Maximum river water temperature (During June)	27^0 C

1.2 RELATIVE HUMIDITY

	Maximum	90%

1.3 RAINFALL DATA

i)	No. of months of tropical monsoon conditions	04
ii)	Average annual rainfall (at Joshimath)	1160 mm
iii)	Average Nos. of rainy days in a year	120
iv)	Occurrence of fog conditions	Nil

1.4 ALTITUDE

i)	Dam site(River Bed)	El 1225 m
ii)	Power House (Service bay level)	El 1041 m
iii)	Switchyard (Potyard over ground)	El 1130 m

2. SEISMICITY

The Project Area lies in the Himalayas which are known as a highly seismic belt.
Seismic data obtained from the Indian Meteorological Department to cover the area between latitude $28^0 – 32^0$ N and longitude $76.5^0 – 80.5^0$ E covers 1169 shocks recorded between the year 1720 to 2005 of magnitude 1.1 to 6.8 at Richter's Scale.
The Seismic Coefficient for the design of the equipment will be considered as specified in Bid Documents.

3. LOCATION AND ACCESS

The site is well connected with all weather roads and is connected to Ghaziabad-Haridwar-Rishikesh-Srinagar-Pipalkoti-Joshimath National Highway No. 58. The project site is about 225 km from Rishikesh.

4. HYDROLOGY

The river Alaknanda drains a catchment area of about 4672 Sq. km. at the proposed dam site. The water availability for the project i.e. the dependable flows for 90 % & 50% dependable year have been assessed as 3737Mcum and 5673 Mcum. The computed inflow series worked out has been adopted as 6700 m^3 /sec as SPF for design of spilling arrangement and the system has been checked for safe passage of PMF i.e. 10800 m^3 /sec.

5. POWER POTENTIAL STUDIES

The 33 years data of water flows on 10 daily basis has been analyzed. For determining 90 % & 50% dependable energy year, the power potential & energy generation for all the 33 years have been computed. An installation of 444 MW comprising generating units each of size 111MW have been proposed. The energy in 90 % dependable year has been summarized below.

Annual Energy Generation

Annual energy generation (GWh)	1812.90
Annual load factor (%)	46.61

Generation during lean flow season

Lean Period Avg. Power (MWc)	74.69
Load factor (%)	16.82

The design energy for tariff at 95% availability in 90 % dependable year has been worked out as 1797.12 GWh.
A pondage of 2.473 Mcum has been provided at diversion dam site, which would enable the station to operate **3.15hrs. per day.**

6. POWER EVACUATION ASPECTS

The 444 mw power generated at 13.8 kv at vishnugad pipalkoti hydro electric project, will be stepped upto 400 kv by unit step transformers. The power will be taken to pooling station near kuwari pass.

7. ENVIRONMENTAL ASPECTS

The proposed project entails submergence of 24.5 ha of area. Mainly forest and partly private land are coming under reservoir submergence. The key impacts are given as below:

- Impacts due to acquisition of forestland.
- Impacts on wildlife, especially species categorized as Schedule-I species as per Wildlife Protection Act (1972)
- Increased potential for fisheries in the reservoir as a result of construction of dam.
- Proper stabilization of quarry sites
- Management of pollution from various sources for labour camps
- Resettlement and Rehabilitation plan for families losing private land and homesteads in project affected villages.

As a part of IEE various management measures including pollution control measures during construction phase, minimal acquisition of forest area, compensatory afforestation, resettlement & rehabilitation plans, area development activities, installation of cyclones /in crushers, etc.

The proposed project is recommended for environmental clearance, which will require approval from Ministry of Environment and Forests, Government of India.

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4. Salient Features

I. LOCATION:

State	Uttarakhand
Distt.	Chamoli
River	Alaknanda
Dam site	Near Village Helong (E – 79^0 29'30") (N - 30^0 30'50")
P H site (underground)	Near Village Hat (E – 79^0 24'56") (N - 30^0 25'31")

II. HYDROLOGY:

Catchment Area at Dam Site	4672 km2
Annual mean flow	5682.6 Mcum
Submergence area	24.5 ha
Design Flood	SPF 6700m^3/sec (For Design) PMF 10840M^3/SEC (FOR CHECKING)
Diversion Flood (1: 25 yr Non monsoon flood)	725 m^3/sec

III. RESERVOIR:

Full reservoir level	E L 1267 m
Maximum Water level	E L 1269 m (PMF)
Minimum Draw Down level	E L 1252.5 m
Gross storage at FRL	3.63 Mcum
Storage at MDDL	1.16 Mcum
Live storage	2.47 Mcum
Surface Area at FRL	24.5 ha

IV. DIVERSION ARRANGEMENT:

A. Diversion Tunnel:

Location	Left bank
Length	490m
Diameter	10m, Circular
Design Discharge	725m^3/sec
Gates	10mx10m, Vertical lift fixed wheel
Invert level at Entry	1228m

B. U/S Coffer Dam:

Type	Colcrete
Length	60 m
Height	15 m
Top Elevation	EL 1242 m

C. D/S Coffer Dam:

Type	Rock fill
Length	46 m
Height	6 m

Top EL.	EL. 1229 m

V. DIVERSION DAM:

Type of dam	Concrete, gravity dam
Height of dam above deepest foundation level	65 m
Top of dam	EL 1270 m
River bed level	EL 1225 m
Foundation level	EL 1205 m
Length	89.3 m (NOF 32.3 m, OF 57.0 m)

VI. SPILLING ARRANGEMENT:

A. Sluices:

Nos.	4
Design Flood	8004 m^3 /sec
Size of sluice	6.6 m (W) x 15 m (H) (4 nos. 6.6 m x 15 m)
Type of gate	Radial Stoplog (1 no. 6.6 m x 22.5 m)
Crest level of sluice	1233 m

B. Diversion cum Spillway Tunnel: Diameter 10 m (Φ) ,Circular

Invert level at Entry	1249 m
Length	490 m
Design Discharge	1074 m^3/sec
Gate	2+1 no., 4.1 m x 10 m (Vertical lift fixed wheel Gate)

C. Spill Tunnel (12m Φ):

Size	12m Φ, Circular
Invert level at Entry	1245 m
Length	250 m
Design Discharge	1618 m^3/sec
Gate	2+1 no., 4.8 m x 12 m (Vertical lift fixed wheel Gate)

D. Ogee spillway

No.	1
Type of gate	vertical
Size	4 m x 3 m
Design flow	80 m^3 /sec
Crest EL	EL 1264 m

VII. POWER INTAKE:

Location	Right bank
Nos.	3
Type	Straight intake with bell mouth
Maximum discharge	277.9 m^3/sec
Intake invert level	EL 1242.5 m
Size	6 m modified Horse shoe type
Gates	3 + 3 nos. 5.20 m x 6 m Vertical lift fixed wheel gate (service gate + emergency gate)
Silt Flushing Tunnel (Below Intake)	
Size of Intake	3 nos. of 3mx3m
Size of SFT ducts	3 nos. of 2mx5m
Gate	3+3 nos. of 3mx3m
Design Discharge capacity	380 cumec

VIII. DESILTING CHAMBER:

Nos.	3
Size	350 m (L) x 16 m (W) x 20.6 m (H)
Particle size to be removed	0.2 mm & above
Gates	3 nos. 5.24 m x 6 m (H), Vertical lift fixed wheel
Gate chamber	6 m (W) x 9 m (H) x 155 m (L)
Operation level	EL 1270 m
Silt Flushing Tunnel:	
Size	3.6 m x 4.0 m (D shaped)
Flushing discharge	47.6 m^3/sec
Length	680 m
Gates	3 nos. 2.5 m x 2.85 m, (Vertical lift slide Gate)
Gate chamber	4.8m x 4.8m x 118 m
Operation level	EL 1233.5 m

IX. HEAD RACE TUNNEL:

Length	13.4 km
Diameter	8.8 m (Horse shoe)
Design discharge	228.86 m^3/sec
Velocity	3.56 m/sec
Bed slope (average)	1:208
No. of adits	4

X. UPSTREAM SURGESHAFT:

Type	Restricted Orifice type
Diameter	22/15 m Φ (22m Φ from EL.1185m to EL. 1240m) (15m Φ from EL.1240m to EL. 1305m)
Height (from HRT invert)	130 m
Top EL	1305 m
Orifice level	1185 m
Orifice diameter	1.5m
Tunnel invert	EL 1175 m
Pressure shaft gates	2 nos., 4.2 m x 5.2 m

XI. BUTTERFLY VALVE CHAMBER:

Size	50 m (L) x 9.8 m (W) x 19 m (H)
Butterfly Valve	2 nos., 5.2 m dia

XII. PRESSURE SHAFT:

Nos.	2 / 4
Type	Circular
Diameter	5.2 m / 3.65 m
Length of each PS	351 m / 36.7 m
Design velocity	5.39 m/sec

XIII. POWER HOUSE:

Type	Underground
Size of P/H cavern	127 m x 20.3 m x 50 m
Size of Transformer cavern	112 m x 16 m x 24.5 m
Nos. of units	4
Rated unit capacity	111 MW
Installed capacity	4 x 111 MW = 444 MW
Gross Head	237.0 m
Rated Head	212.46 m
Centre line of unit	EL 1022.0 m
Service bay level	EL 1038 m
Main Inlet Valve (Spherical valve)	3.0m dia, Design Pressure 28.2 Kg/cm^2
Maximum flow through each unit	57.22 m^3/sec
Generator:	
Synchronous speed of Generator	250 rpm
Power factor, Generator voltage	0.9, 13.8kV
Excitation system	Quick response static
Transformers- Type, Nos, No. of Phases,	OFWF, 4, 3, single phase, 46MVA, 13.8/ 420/√3kV.
Step-up voltage, Capacity	400kV

Energy generation (on 90% dependability basis)	1813.03 GWh

XIV. D/S SURGE TANK:

Type	Underground
Size	120 m (L) x 12 m (W) x 27 m (H)
Maximum Surge level	1040 m
Minimum Surge level	1026.5 m

XV. TAIL RACE TUNNEL:

a) Size	8.8 m ϕ (Horse shoe)
b) Length	3.07 km
c) Max. TWL	1030.0 m (with all M/C running)
d) Min. TWL	1027.2 m (with 10% load)
e) TRT invert level	EL 1025.0 m

XVI. SWITCHYARD:

a) Type of Switchyard	GIS
b) No. of bays in the switchyard	7 bays
c) Voltage level	420 kV
d) Size of potyard	40m x 60 m

XVII. POWER GENERATION:

a) Firm power	74.69 MW
b) Annual Energy	1813.03 GWh
c) Load factor (lean flow)	16.82%
d) Design Energy	1797.24 GWh

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SECTION: I

SUB SECTION: C1

TECHNICAL SPECIFICATION

SECTION: I

SUB-SECTION: C 1

SPECIFIC TECHNICAL REQUIREMENT

1. FUNCTION

The purpose of the system is to provide Air-Conditioning & Ventilation for different areas of underground hydro power plant VISHNUGAD PIPALKOTI (4 x 111 MW). To achieve proper working conditions, HVAC system is provided to serve the following purpose:

a. To prevent temperature stratification
b. To remove contaminated air
c. To remove waste heat from equipment
d. To provide outside fresh air necessary for human comfort
e. To evacuate smoke and remove heat

2. SYSTEM DESCRIPTION

Conditioned and dehumidified air shall be supplied to different zones of the powerhouse in accordance with heat generated in each zone. The power station shall be divided into two zones as below:

(A) Air Conditioning Zone
(B) Ventilation zone

3.1 AC SYSTEM ZONE CONSIST OF THE FOLLOWING AREAS.

3.1.1 Ductable Split ACs shall be provided to cater to the air conditioning requirements of the control room at EL. 1041.5M at control block.

3.1.2 Non Ductable Split ACs shall be provided to cater to the air conditioning requirements of Electrical W/S and Test Lab at EL. 1030.5M, office room/record room at EL. 1036.0M, office room & conference room at EL. 1041.5M & office room/ store at EL. 1047.00M of control block.

3.1.3 Ductable Split ACs shall be provided to cater to the air conditioning requirements of the control room at EL. 1046.0 M at GIS Floor.

3.1.4 Non Ductable Split ACs shall be provided to cater to the air conditioning requirements of Control Room at Dam gallery.

3.2 VENTILATION SYSTEM ZONE CONSIST OF THE FOLLOWING AREAS

3.2.1 ONCE THROUGH TYPE VENTILATION SYSTEM

Once Through type ventilation system shall be provided for following areas:

Supply air from once through AHU shall be fed to various areas of power house, Transformer floor & GIS floor as detailed below through insulated duct

3.2.1.1 MIV floor at EL. 1017.00M.

3.2.1.2 Turbine floor at EL. 1025.70M.

3.2.1.3 Generator Floor at EL. 1030.50M.

3.2.1.4 Machine floor at EL. 1036.00M.

3.2.1.5 Service Bay area EL. 1036.00M.

3.2.1.6 Transformer Floor at EL. 1036.00M.

3.2.1.7 GIS Floor at EL. 1046.00M.

3.2.1.8 Bus duct tunnels from Machine floor to Transformer floor.

3.2.1.9 Mechanical W/S and Waste water collection & Pumping Room at EL. 1030.50M of Control Block

3.2.1.10 LT room at EL. 1036.0M of Control Block.

3.2.2 DRY TYPE MECHNICAL VENTILATION SYSTEM

Dry Mechanical type Ventilation System shall be provided for following areas:

3.2.2.1 Toilets, Pantry and Battery Room for power house, Transformer & GIS cavern.

3.2.2.2 Main Access Tunnel (MAT).

3.2.2.3 Surge Shaft area at start of TRT.

3.2.2.4 Butterfly Valve House, Penstock Assembly chamber and its Adits

3.2.2.5 Switchgear room, DG room, toilet at Pothead yard.

3.2.2.6 Staircases of Power house and Transformer Cavern. (In case of Fire)

3.2.2.7 Cable Ventilation Tunnel (CVT)

3.2.2.8 Desilting gate operation chamber and its adit.

3.2.2.9 Silt Flushing Tunnel and its adit.

3.2.2.10 Adit to DC top.

3.2.2.11 Dam Galleries

4 DESIGN CRITERIA

4.1 SYSTEM DESIGN CRITERIA – AMBIENT CONDITIONS

4.1.1 The outside design conditions considered shall be under: -

	Summer	Monsoon	Winter
DBT (°C)	31	30	0
WBT (°C)	26.36	29.9	-1.6

Note: 70%RH Considered for Summer & Winter. 95% RH considered for Monsoon.

Density of air for Summer - 1.146 kg/m^3
Density of air for Winter - 1.290 kg/m^3

4.2 SYSTEM DESIGN CRITERIA - AIR CONDITIONING SYSTEM

4.2.1 The inside design conditions to be maintained shall be as under: -

23°C ± 1°C, 50 % ± 5%

4.2.2 Fresh air requirement shall be minimum 1.0 air change per hour for control room areas or 16 CFM per person whichever is higher for areas served by non-duct-able split ac.

4.2.3 A design margin of 10% on total sensible and latent heat shall be considered while designing the AC Plant capacity for each area.

4.2.4 Necessary Heater shall be provided (if required).

4.2.5 The maximum air velocity through Air conditioning duct shall be 7.6 m/sec.

4.2.6 Lighting load considered shall be 1 W/sqft.

4.2.7 The occupancy considered shall be 1 person in 25 Sqm. or actual.

4.2.8 Relative humidity shall not be controlled by areas being served by non-duct-able split ACs.

4.3 SYSTEM DESIGN CRITERIA - VENTILATION SYSTEM

4.3.1.1 Inside design temperature 25-28°C & RH <65% for areas being served by once through AHUs.

4.3.1.2 During Winters the inside temperature maintained shall be 18°C.

4.3.1.3 Ventilation provision for various location is envisaged as follows

S.No.	Name of premises	Type of Ventilation	ACPH
1.	Staircase area	**Supply Air:** Through Louvres (in normal condition) Through Fresh air fan placed at blower room at CVT portal. (in case of fire)	4
2.	Battery room in power house, GIS/Transformer cavern, Butterfly Valve house.	**Supply Air:** Through Louvres/Supply Air Duct **Exhaust Air:** Centrifugal Exhaust Fan (spark proof with flame proof motor)	8
3.	Machine Hall	**Supply Air:** Once Through water System through AHUs at control block **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans at blower room at CVT portal	2
4.	Service bay	**Supply Air:** Once Through water System through AHU at control block **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans at blower room at CVT portal	2
5.	Transformer/GIS Cavern	**Supply Air:** Once Through water System through AHU at GIS Floor **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans at blower room at CVT portal	4
6.	Bus Duct Tunnel	**Supply Air:** Once Through water System through AHU at GIS Floor **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans at blower room at CVT portal	4
7.	Switchgear room in power house	**Supply Air:** Once Through Water System through AHU at control block	4

		Exhaust Air: Through gravity damper.	
8.	Generator floor	**Supply Air:** Once Through water System through AHU at control block **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans blower room at CVT portal	2
9.	Turbine floor	**Supply Air:** Once Through water System through AHU at control block **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans blower room at CVT portal	2
10.	Mechanical workshop	**Supply Air:** Once Through Water System through AHU at control block **Exhaust Air:** Through gravity damper.	4
11.	MIV Floor	**Supply Air:** Once Through water System through AHU at control block **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans blower room at CVT portal	2
12.	Butterfly valve house, Penstock Assembly Chamber	**Supply Air:** Centrifugal Supply Fans **Exhaust Air:** Cabinet type Centrifugal Exhaust Fans	2
13.	Adits for Butterfly valve house and Penstock Assembly Chamber		1
14.	DG set Room at Pothead yard	**Supply Air:** Through Louvres **Exhaust Air:** Wall mounted axial flow exhaust fans.	8
15.	Toilets & pantries for Power House	**Supply Air:** Through Door undercuts **Exhaust Air:** Centrifugal Exhaust Fan	8
16.	Switchgear room at Pothead yard	**Supply Air:** Wall mounted axial flow Supply fans **Exhaust Air:** Through Gravity Dampers	4
17.	Toilets & pantries outside Power House	**Supply Air:** Through Door undercuts **Exhaust Air:** Propeller Exhaust Fan	8
18.	MAT	**Exhaust Air:** Cabinet type Centrifugal Exhaust Fan at CVT Portal **Supply Air:** Through Fresh Air Supply Fan at CVT Portal (only in case of fire)	1
19.	Escape Tunnel	**Supply Air:** Once Through water System through AHU	1
20.	Drainage and Dewatering Gallery	**Supply Air:** Once Through water System through AHU at Control Block **Exhaust Air:** Centrifugal Exhaust Fans at CVT Portal	2
21.	Cable &Ventilation Tunnel	**Exhaust Air:** Centrifugal Exhaust Fan at CVT Portal	1
22.	SURGE CHAMBER AT START OF TRT	**Exhaust Air:** Centrifugal Exhaust Fan	1
23.	DAM AREA (Above	Combination of Axial Supply Air Fans/ Exhaust	2

	Ground)	Fans and Gravity Damper/Louvres.	
24.	TRT Areas (Above Ground)	Combination of Axial Supply Air Fans/ Exhaust Fans and Gravity Damper/Louvres.	2
25.	Silt Flushing Gate Operation Chamber	**Supply Air:** Centrifugal Supply Fan **Exhaust Air:** Cabinet type Centrifugal Exhaust Fan	2
	Adit to Silt Flushing Gate Operation Chamber		1
26.	Desilting Gate Operation Chamber	**Supply Air:** Centrifugal Supply Fan **Exhaust Air:** Cabinet type Centrifugal Exhaust Fan	2
	Adit to Desilting Gate Operation Chamber		1
27.	Battery Room (overground)	**Supply Air:** Gravity Dampers **Exhaust Air:** Bifurcated Axial Exhaust Fan	8
28.	Adit to DC top	**Supply Air:** Centrifugal Supply Fan **Exhaust Air:** Cabinet type Centrifugal Exhaust Fan	1
29.	Dam Galleries	**Supply Air:** Centrifugal Supply fan (with booster fans if required)	2

4.3.2 Air quantities shall be calculated based on heat load basis for Powerhouse and Transformer/GIS cavern areas based on heat dissipation values from the various equipment and other heat source in various areas and the air quantity calculated based on air changes per hour and adopting higher of the two values.

4.3.3 The maximum air velocity through ventilation main header duct shall be 12 m/sec. & for branch ducts shall be lower than 11m/s and through AC ducts shall be 7.5m/sec. However, velocity may exceed these values locally due to layout constraints. Velocity through ventilation grilles shall be 5 m/s and through AC diffusers shall be 2.5m/s.

4.3.4 Complete Structural work for erection of mechanical, electrical and C & I equipment, support for duct/fans/pipes/cable tray etc. is in bidder's scope.

Following may please be noted.

1) Duct rack for routing supply/exhaust duct/cable trays etc. from ventilation air blower rooms till entry to tunnel is in bidder's scope.

- Blower room near CVT till entry to CVT & MAT
- Blower room near Butterfly valve chamber & Penstock assembly chamber adit till entry to tunnel
- Blower room near Desilting Gate operation chamber adit till entry to tunnel.
- Blower room near Silt flushing Gate operation chamber adit till entry to tunnel.
- Blower room near AC top adit till entry to tunnel.
- Fan near Dam gallery till entry to Dam/ Dam Gallery.

Civil Structural design of above structure using STAAD or equivalent software as per relevant standards shall be in scope of vendor.

Details of Duct Racks are mentioned in tender drawing no. PE-DG-413-11000A-SK001.

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

3) Anchor fastener/HILTI fasteners shall be used by vendor for fixing duct/ pipes etc. wherever applicable.

4) Duct supporting and accessories material (for entire scope of ducts) such as hangers, tie rods, nut, bolts, lock nut, washer, HILTI fastener, gasket, bracing, adhesive, sealant, rivets, angles, channels, bracket support etc. for completeness of duct installation in all aspects shall be in bidder scope. The only primary support that shall be available shall be columns & beams of Powerhouse, Transformer/GIS caverns and other buildings. Every other duct support structure required shall be in bidder's scope.

Rectangular ducts of size upto 750mm and above shall be supported by 15mm M.S. rods and 50 x 50 x 3 mm M.S. angles while ducts below 750mm shall be supported by 10 mm M.S. rods and 40 x 40 x 3mm M.S. angles. The M.S. rods and angles shall be given a coat of primer paint. Arrangement like drilling and placing anchor fasteners for duct support, auxiliary or special steel members, hooks coach screws and all other supporting material required shall be provided. wherever the ducts are thermally insulated the M.S. angles and supports shall not be in direct contact with ducts.

5) Any other type of structural work for complete HVAC system is deemed to be in bidder's scope even though specifically not mentioned above.

4.4 CODES AND STANDARDS

The following standards, codes and technical documents are used for the design of HVAC system.

ASHRAE / ISHRAE Guide and data book, American Society of Heating, Refrigerating and Air Conditioning Engineers.
IS: 4720 Code of practice for ventilation of surface hydel power stations
IS: 3103 Installation, operation, testing and maintenance of ventilation system
IS: 4894 Centrifugal fans
IS: 2312 Propeller type AC ventilating fans
IS: 1822 AC motor starters of voltage not exceeding 1000 volts
IS: 655 Specification for metal air ducts
IS: 4029 Guide for testing of three phase induction motor
IS: 900 Induction motor installation and maintenance code of practice
IS: 277 Specification for galvanised steel sheets
IS: 325 Induction motors
IS: 3589 Electrically welded steel pipes
IS: 3588 Specification for electric axial flow fans
IS: 737 Specification for wrought aluminum or aluminum alloys sheet and strip
IS: 661 Code of practice for insulation.
BS: 2831 Methods of test for air filters used in air conditioning and general ventilation
IS: 3069 Glossary of terms, symbols and units relating to thermal insulation material.
IS: 4671 Expanded polystyrene for thermal insulation purpose.

4.5 GENERAL PRINCIPLES

4.5.1 Cooled air shall be supplied generally at low points of the powerhouse and exhaust air shall be at high points.

4.5.2 Areas such as battery room, toilet and pantry which are exposed to harmful gases or odors shall be maintained at negative pressure and these harmful gases / odors shall be exhausted outside the power building with the help of separate exhaust air fans.

4.5.3 Lighting load considered shall be 1 Watts/sq. feet.

4.5.4 All the equipment for HVAC system shall be designed for continuous duty.

5. GENERAL DESCRIPTION OF VENTILATION AND AIR CONDITIONING SCHEME

5.1 VENTILATION SYSTEM

5.1.1 POWER HOUSE AREA, TRANSFORMER/GIS CAVERN & BUS DUCT GALLERIES

5.1.1.1 Once through type Ventilation system shall be provided for maintaining an air temperature of 25-28°C in summer season & 18 °C in winter season with RH ≤65% considering a maximum river water temperature of 14°C.

5.1.1.2 The supply air quantity requirement will be worked out based on heat load calculation from first principle as well as for maintaining minimum no. of air changes as per IS:4720. The higher value of the two shall be adopted for supplying air to various areas of power house & GIS/Transformer Cavern bus duct galleries.

5.1.1.3 In order to meet the above requirements, 1 set of 3x50% Air Handling Units (AHU) shall be provided for Power house area and 1 set of 3x50% Air Handling Units (AHU) shall be provided for GIS/Transformer cavern and Bus duct galleries.

5.1.1.4 AHU units for power house ventilation requirements shall be placed at EL.1052.00M of control block and AHU units for GIS/Transformer cavern and Bus duct galleries shall be placed at GIS Floor at EL. 1046.0M. These units shall be in floor mounted, comprising of fresh and return air dampers, Pre-filters, cooling coil section and fan section having supply air centrifugal fan and shall supply the cooled air to the various areas of the power house building, GIS/Transformer Cavern & bus duct galleries with the help of air conveyance ducting and grilles.

5.1.1.5 Cooling water for these AHUs shall be provided through centrifugal cooling water pumps located at MIV floor EL. 1017.00M (2x100% redundancy).

5.1.1.6 The fresh air for power house building including control block, GIS/Transformer Cavern & bus duct galleries and Escape tunnel that shall be provided shall be 25% of the total AHU supply air quantity required. The fresh air shall be provided from fresh air blowers (2x50% redundancy) placed at ventilation blower room outside CVT portal through ducting. These fresh air fans will supply fresh air up to Air Handling Units (AHUs) of Power House & Control Block located atEl.1052.00 M and AHUs of GIS, Transformer cavern and Bus duct galleries located at El.1046.00M Necessary fresh air filters, louvers and bird screen shall be provided at the suction of fresh air fans.

5.1.1.7 Return air from Power house shall travel from MIV floor to Machine Hall floor through MIV hatches provided on each floor. Further this return air shall be collected through main return air header duct routed above EOT crane at roof level. After collecting return air of power house, this return air duct shall travel back up to AHUs located on HVAC room floor. Return air for GIS/Transformer halls shall be collected using return air duct and the return air shall travel back to AHUs at GIS floor.

5.1.1.8 For Exhaust of Stale air from power house building including control block, GIS/Transformer Cavern & bus duct galleries, 60% of the fresh air supplied shall be exhausted (i.e. 15% of total AHU supply air) through cabinet type centrifugal exhaust fans (2x100% redundancy) placed at roof of ventilation blower room outside CVT portal through ducting. In case of smoke both exhaust fans shall start working for quick exhaust of smoke. Return air ducts of power house and GIS caverns and the exhaust duct in CVT shall be used for smoke exhaust.

5.1.1.9 For winter heating of power house, strip heater of suitable capacity shall be considered.

5.1.1.10 The exhaust air from toilets (2x50%redundancy) and battery room (2x100% redundancy) in power house/GIS Transformer cavern shall be evacuated by means of separate exhaust system consisting of dedicated centrifugal exhaust fan and ducting. The ducts for Battery rooms shall be MS epoxy painted. Centrifugal Fans for Battery rooms shall also be epoxy painted. Motors of Battery room shall be flame and spark proof. A dedicated duct for battery rooms shall be used and its discharge shall be at CVT Portal.

5.1.1.11 Automatic motorized dampers shall be provided at fresh air inlet, return air inlet & discharge duct of AHU's.

5.1.1.12 For smoke exhaust, both the centrifugal exhaust fans provided at ventilation blower room shall be operational for quick exhaust of smoke from the power house and GIS/Transformer cavern. Fresh air supply shall be turned off during smoke exhaust.

5.1.1.13 The purpose of the staircase pressurization system is to provide safe egress and secure path for exit of plant personnel during fire exists. For that fresh air shall be taken from outside and then discharged into staircases to build up high positive pressure for staircases. In case of fire, stairs have to be pressurized by providing fresh air in some minimal quantity to the whole zone and recirculation of air through AHUs shall be stopped. In case of fire, fresh air to AHUs shall be stopped and this fresh air shall be routed to the staircases. Fresh air fan placed at CVT portal shall be used for supply of this fresh air. During normal condition, AHU supply air through louvres shall be provided to staircases.

5.1.1.14 Supply air duct for power house areas shall be routed through machine hall areas below crane maintenance cage along B row. Droppers from this header shall be used to supply air to generator floor, turbine floor, MIV floor. Return air duct shall be routed in the crown area. In Transformer/ GIS cavern, duct supply air duct shall be routed through GIS floor and Transformer floor along F line. Return air duct shall be routed through GIS floor along E line. Droppers from this header shall be used to collect return air from transformer hall. Branches of Supply and return air duct shall be routed from transformer hall to each bus duct cavern for its ventilation. Fresh air, Exhaust air and Battery/Toilet exhaust shall be routed through CVT. Suitable modifications can be done during detail engineering.

5.1.2 BUTTERFLY VALVE HOUSE & PENSTOCK ASSEMBLY CHAMBER

5.1.2.1 Fresh air for butterfly valve house & penstock assembly chamber and its Adits shall be provided from centrifugal supply air fans (2x100% redundancy), placed at ventilation blower room at portal of butterfly valve house adit through ducting.

5.1.2.2 The supply air quantity requirement will be worked out based on Air changes per hour (ACPH) method as there not many heat dissipating equipment. ACPH of 2 shall be considered for chambers and 1 ACPH for Adits

5.1.2.3 Exhaust air of Butterfly valve house & penstock assembly chamber and its Adits shall be done through cabinet type centrifugal exhaust fan (2x100% redundancy) placed at roof of ventilation blower at portal of butterfly valve house adit through ducting. Grilles shall be provided in exhaust air duct in the adit for ventilation of the adit. 60% of supplied air shall be exhausted.

5.1.2.4 Battery room inside butterfly house shall be ventilated through separate exhaust fans (2x100% redundancy) placed at ventilation blower room at portal of butterfly valve house adit through ducting.

5.1.2.5 Pre-filters, dampers, grills, louvers wherever required for above units shall be provided.

5.1.2.6 For smoke exhaust, both the fans provided for normal exhaust (1W+1S) shall start working for faster removal of smoke.

5.1.3 SWITCHGEAR BUILDING/DG ROOM AT POTHEAD YARD

5.1.3.1 Supply air shall be provided with the help of wall mounted axial flow air fan for switchgear room. These fans shall be comprising of Pre & fine filters. In order to create positive pressure inside switchgear room, 60% of supply air shall be exhausted with the help of gravity dampers.

5.1.3.2 For DG Room, bifurcated type wall mounted axial flow exhaust fan with spark proof motor shall be provided and fresh air shall be taken through inlet louvres.

5.1.3.3 Bird screen, grills, louvers wherever required for above units shall be provided.

5.1.3.4 Propeller type axial fans shall be provided for toilets.

5.1.4 AUXILIARY BUILDING AT DAM/DESILITING AREAS

5.1.4.1 Wall mounted axial flow exhaust fans shall be provided and air should be supplied through inlet louvres.

5.1.4.2 Propeller type axial fans shall be provided for toilets

5.1.5 DOWNSTREAM SURGE CHAMBER

5.1.5.1 1 No. Centrifugal exhaust fan shall be provided and exhaust air shall be ducted through MAT. Centrifugal exhaust fan shall be placed at the surge chamber.

5.1.6 MAIN ACCESS TUNNEL

5.1.6.1 In normal condition the air shall be exhausted through ducting connected to centrifugal exhaust fans placed in ventilation blower room at CVT portal. In case of fire a damper shall be operated to close the exhaust, air duct and air shall be supplied through ducting connected to centrifugal supply fans placed in ventilation blower room at CVT portal.

5.1.7 DESILTING GATES OPERATION CHAMBER

5.1.7.1 1 No. Centrifugal Supply air fans shall be provided for desilting gate operation chamber and its adit. 60 % of this air shall be exhausted using 1 No. cabinet type centrifugal exhaust fans. These fans shall be placed at portal of Desilting gate operation chamber adit.

5.1.8 SILT FLUSHING GATES OPERATION CHAMBER

5.1.8.1 1 No. Centrifugal Supply air fans shall be provided for silt flushing gate operation chamber and its adit. 60 % of this air shall be exhausted using 1 No. cabinet type centrifugal exhaust fans. These fans shall be placed at portal of silt flushing gate operation chamber adit.

5.1.9 ADIT TO DC TOP

5.1.9.1 1 No. Centrifugal Supply air fans shall be provided for adit to DC top. 60 % of this air shall be exhausted using 1 No. cabinet type centrifugal exhaust fans . These fans shall be placed at portal of adit to DC top.

5.1.10 CABLE VENTILATION TUNNEL

5.1.10.1 Air from the CVT shall be exhausted using the exhaust air duct of the power house/Transformer GIS cavern travelling via CVT.

5.1.11 DAM GALLERIES

5.1.11.1 Fresh air shall be supplied using 1 No. centrifugal supply fan. Booster fans shall be installed if required. Flexible Duct/Hose shall be used to supply air routed through staircases.

5.2 AIR-CONDITIONING SYSTEM

5.2.1 POWER HOUSE AREA, TRANSFORMER/GIS CAVERN

5.2.1.1 Ductable Split AC shall be provided for following areas

Sr. No.	Area to be Air-Conditioned	Redundancy
1.	Control Room at 1041.5M at control block	3x50% Redundancy
2.	Control Room at EL. 1046.0M at GIS Floor	3x50% Redundancy

5.2.1.2 For heating requirements, oil filled heater shall be provided.

5.2.1.3 Humidifiers shall be provided for humidity control of above AC areas being served by ductable split ACs.

5.2.1.4 Non ductable Split ACs shall be provided for following areas

Sr. No.	Area to be Air-Conditioned	Redundancy	Remarks
1.	Electrical W/S and Test Lab at EL. 1030.5M of Control Block	All working, no stand-by.	Capacity shall be decided as per Heat load calculations during detail engineering.
2.	Office room/Record room at EL. 1036.0M of control block	All working, no stand-by.	
3.	Office room at EL. 1041.5M EL of control block	All working, no stand-by.	
4.	Conference room at EL. 1041.5M EL of control block	All working, no stand-by.	
5.	Office room/store at EL 1047.00M of control block	All working, no stand-by.	
6.	TRT Areas	All working, no stand-by.	

5.2.1.5 For heating requirements, oil filled heaters shall be provided with local on/off control for above areas being served by non ductable split ACs.

5.2.1.6 Humidity control shall not be applicable for areas being served by non ductable split AC.

5.2.2 CONTROL BUILDING AT DAM AREA & POTHEAD YARD AREAS

5.2.2.1 Non ductable Split type air conditioners of suitable capacity (N+1 redundancy, where N is the no. of working units) shall be provided for air conditioning of control room of Dam area and Pothead Yard area.

5.2.2.2 For heating requirements, oil filled heaters shall be provided with local on/off control. for above areas being served by non ductable split ACs.

5.2.2.3 Humidity control shall not be applicable for areas being served by non ductable split AC.

6. LAYOUT CONSIDERATIONS:

6.1 VENTILATION SYSTEM

6.1.1 Ventilation equipment shall be placed at following locations

Sr. No.	Equipment	Redundancy	Location
1.	3 Nos. AHUs for Power House Ventilation.	3x50%	At EL. 1052.00M of Control Block. Grids C-D-1-2.
2.	3 Nos. AHUs for GIS/Transformer cavern and bus duct galleries.	3x50%	At. EL. 1046.00M of GIS Floor. Grids E-F-24-26.
3.	2 Nos. Centrifugal Fresh Air Fans.	2x50%	Ventilation blower room near CVT portal.
4.	2 Nos. Cabinet type Centrifugal Exhaust Fan	2x100%	Roof of Ventilation blower room near CVT portal.
5.	2 Nos. Centrifugal Exhaust fans for battery room at control block.	2x100%	At EL. 1052.00M of Control Block.
6.	2 Nos. Centrifugal Exhaust fans for battery room at GIS Floor.	2x100%	Near Battery room of GIS Floor.
7.	2 No. Centrifugal Exhaust fan for Toilet/Pantry of Power House.	2x50%	At EL. 1052.00M of Control Block.
8.	2 Nos. Centrifugal Supply fan for Butterfly valve house, Penstock assembly chamber and its adit	2x100%	Ventilation blower room at portal of Butterfly Valve adit
9.	2 Nos. Cabinet type Centrifugal Exhaust fan for Butterfly valve house, Penstock assembly chamber and its adit	2x100%	Roof of Ventilation blower room at portal of Butterfly Valve adit
10.	2 Nos. Centrifugal Exhaust fan for Battery room at Butterfly valve house.	2x100%	Ventilation blower room at portal of Butterfly Valve adit
11.	2 Nos. Centrifugal Pump for Cooling Water.	2x100%	At EL. 1017.0M MIV Floor Grids B-C-3-4
12.	1 No. Centrifugal Supply fan for Desilting gate operation Chamber and its adit.	1x100%	Blower Room At portal of Desilting gate operation Chamber adit.
13.	1 No. cabinet type Centrifugal exhaust fan for Desilting gate operation Chamber and its adit.	1x100%	Roof of Blower Room At portal of Desilting gate operation Chamber adit.
14.	1 No. Centrifugal Supply fan for Silt Flushing gate operation Chamber and its adit.	1x100%	Blower Room At portal of Silt Flushing gate operation Chamber adit.
15.	1 No. cabinet type Centrifugal Exhaust fan for Silt Flushing gate operation Chamber and its adit.	1x100%	Roof of Blower Room At portal of Silt Flushing gate operation Chamber adit.

16.	1 No. Centrifugal Supply fan for Adit to DC top.	1x100%	Blower Room At portal of adit to DC top.
17.	1 No. cabinet type Centrifugal exhaust fan for Adit to DC top.	1x100%	Roof of Blower Room At portal of adit to DC top.
18.	1 No. cabinet type Centrifugal exhaust fan for Downstream Surge Chamber.	1x100%	At Downstream surge chamber
19.	1 No. cabinet type Centrifugal Supply fan	1x100%	Near Dam Galleries Staircase

6.2 AC SYSTEM

6.2.1 Ductable Split ACs wherever provided shall be located above false ceiling. Outdoor unit shall be placed at a suitable location. Complete Cu piping/cabling required b/w indoor and outdoor unit of ductable and non-ductable split ACs shall be provided by supplier.

7. EQUIPMENTS TO BE PROVIDED

7.1 AC EQUIPMENT

7.1.1 DUCT-ABLE TYPE SPLIT AC

As per clause 26.4.2 of Chapter 26- Air Conditioning System of THDC technical specification.

7.1.2 NON-DUCT-ABLE SPLIT AIR CONDITIONER

Non-duct-able Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements as areas as stated in above clause 5.2.

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

7.1.3 SHEET METAL WORK

As per clause 25.6.5 of Chapter 25- Ventilation System of THDC technical specification.

7.2. VENTILATION EQUIPMENT:

7.2.1 AIR HANDLING UNIT (ONCE THROUGH TYPE)

Each air handling unit shall comprise of the following: -

a. Double skin panels (inside and outside) shall be fabricated using **minimum (24 G)** galvanized steel, with 25 mm thick polyurethane insulation of minimum **38 kg/m3** density in between, GSS channels shall be used as reinforcing to give structural strength. 16G MS Structure of Sectionalized construction, insulated SS drain pan, and all accessories as specified are to be provided.
b. Filter section shall be separate.
c. Centrifugal fan shall be as per clause 25.6.1 of Chapter 25- Ventilation System of THDC technical specification

d. Fan-motor set on a common base frame with all drive accessories shall be provided in the fan section and fan section shall be provided with access doo
e. Fan section complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base.
f. 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.
g. Cooling coil of suitable size shall be of seamless copper tubes with aluminum fins and shall be provided with suitable drains and vents connections. The cooling Coil shall be of standard make and mounted in such a way that each element is replaceable and shall be provided with valves for isolation.
   Finned Tube Type Cooling Coil having large surface area shall be made from 18 gauge copper seamless tubes and plate type continuous Aluminium fins 28 gauge, 7 fins per inch. The headers shall also be of seamless copper pipes. The frames shall be made from 10 gauge MS sheet and sand blasted before applying finish paint.
   After inserting the fins over the tubes, the tubes shall be mechanically expanded from inside throughout their length so as to ensure firm contact between the tubes and fin collars for efficient heat transfer.
   Each section of the will be hydraulically tested at 5kg/cm2 pressure and test certificate will be issued.
   Water inlet and out connections shall be of flanged type and flanges shall be as per relevant Indian Standard.
h. Flat filter sections complete with dry panel type filter having efficiency 80% down to 20 microns.
i. Drain piping from the AHUs up to nearest drain point.
j. Lot – vibration isolation pads.
k. Lot- Supply water pipeline for AHUs of ventilation system.

7.2.2 SHEET METAL WORK

As per clause 25.6.5 of Chapter 25- Ventilation System of THDC technical specification.

7.2.3 FRESH AIR BLOWER

a. Fresh air blowers shall be placed in fresh air blower room as stated in above clause 6.1.
b. Centrifugal fans shall be as per clause 25.6.1 of Chapter 25- Ventilation System of technical specification. Suction of fresh air shall be through inlet louvres mounted on walls of blower room.
c. Filters shall be provided as per clause 25.6.3 of Chapter 25- Ventilation System of THDC technical specification

7.2.4 EXHAUST AIR BLOWERS

a. Cabinet type exhaust air blowers shall be placed on outdoor locations as mentioned in above clause 6.1
b. Centrifugal fans shall be as per clause 25.6.1 of Chapter 25- Ventilation System of THDC technical specification.

7.2.5 OTHER CENTRIFUGAL FANS

Centrifugal fans shall be as per clause 25.6.1 of Chapter 25- Ventilation System of THDC technical specification.

Cabinet for Centrifugal Fans wherever required shall be Double skin panels (inside and outside) fabricated using minimum (24 G) galvanized steel, with 25 mm thick polyurethane insulation of minimum 38 kg/m3 density in between, GSS channels shall be used as reinforcing to give structural strength. 16G MS Structure of Sectionalized construction, insulated SS drain pan, and all accessories as specified are to be provided.

7.2.6 AXIAL FLOW FANS

Each wall mounted axial flow fan shall be complete with

a. Fan impeller with aerofoil section of cast aluminium alloy & casing, short duct as required.
b. Electric drive motor with coupling including motor brackets.
c. Inlet cone and grouting framework.
d. Rain protection cowl with bird-screen at inlet & outlet, adjustable damper, vibration isolators, back draft damper, support structure, filter with filter frame and structure as required etc. as required shall be provided.
e. Axial fans will be of propeller type, for fans with 5 mm of wc fan static pressure and Tube Axial type for fans with static pressure above 5 mm of wc.

Wall openings and motor ratings for Axial Fans shall be as follows:

1	Axial flow supply fans with 30 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	2.2 KW	800mmx800mm
b.	7,500 CMH	1.5 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	500mmx500mm
2	Axial flow supply fans with 20 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	10,000 CMH	1.5 KW	800mmx800mm
b.	7,500 CMH	1.1 KW	700mmx700mm
c.	6,000 CMH	1.1 KW	600mmx600mm
d.	4,000 CMH	0.75 KW	600mmx600mm

3	Axial flow exhaust fans (Bifurcated type) with 15 mmwc static pressure.		
a.	Capacity	Motor rating	Wall opening
b.	15,000 CMH	2.2 KW	900mmx900mm
c.	10,000 CMH	1.5 KW	800mmx800mm
d.	7,500 CMH	1.1 KW	700mmx700mm
e.	4,000 CMH	0.75 KW	600mmx600mm
f.	2,000 CMH	0.55 KW	500mmx500mm
4	Axial flow exhaust fans with 10 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	15,000 CMH	1.1 KW	900mmx900mm
b.	10,000 CMH	0.75 KW	800mmx800mm
c.	7,500 CMH	0.55 KW	700mmx700mm
d.	6,000 CMH	0.55 KW	600mmx600mm
e.	4,000 CMH	0.55 KW	600mmx600mm
f.	2,000 CMH	0.37 KW	500mmx500mm
5	Exhaust fan (propeller type) with 5 mmwc static pressure.		
	Capacity	Motor rating	Wall opening
a.	1000 CMH	100 W	300 mm circular

7.2.7 CENTRIFUGAL PUMPS FOR COOLING WATER

a. Centrifugal pump (1017.0M EL near Grid line 4) for taking water MIV floor to AHU's, Horizontal split casing type centrifugal pump of adequate capacity to match the system requirement. (Minimum 300 CMH & 90 M head)
b. One No. adequately sized TEFC sq. cage induction motor per pump suitable for 415 V, 3 phase, 50 Hz AC supply.
c. One set of base plate, coupling guard, anti-vibration pads, foundation bolts etc.
d. Valves, Instruments other fittings etc. along with cooling water pumps.
e. Drain piping from pump to nearest drain.
f. Mechanical seal and all other accessories required shall be provided.
g. MOC of Pump

- Pump casing: Cast steel (ASTN A216 WCB)
- Pump Shaft: Stainless steel (ASI 420 or better)
- Impeller: High grade duplex stainless steel
- Pump Bearings: Anti friction
- Impeller wear rings: Stainless steel
- Casing wear rings: Stainless steel
- Shaft sleeve: Stainless steel Gr. 410H
- Base Plate: MS Plate to IS 2062
- Stuffing box seal: Gland packing/Mechanical seal (C vs SiC & C vs TC)
- Companion Flange: IS 2062 Gr.B
- Insulation class F (temp rise limited to b)

7.2.8 COOLING WATER PIPING

Material: Mild Steel, ERW

Design Code & Dimensions: Heavy Grade, IS :1239 or equivalent, Plain end or Bevel end (For Pipe 150NB & below)
IS: 3589 Grade 410 or equivalent, Plain end or Bevel end (For Pipe 200NB & above) (minimum 6mm thickness)

Fittings: 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. For sizes 50 NB and below, the material shall conform to ASTM A-105.

7.2.9 DRAIN PIPING

Heavy grade-IS:1239 or Equivalent & galvanized as per IS:4736.

7.2.10 FILTERS

Pre-Filters wherever applicable shall be provided as per clause 25.6.3 of Chapter 25-Ventilation System of THDC technical specification

Fine filters wherever applicable shall be as follows

Type	Flange / Cassette
Media	•Washable non-woven synthetic fibre or High density Polyethylene (HDPE) media having 18G GSS / 16G Al alloy frame. •The filter media shall be supported with HDPE mesh on air inlet side & Aluminium expanded metal on exit side or G.I. wire mesh on both sides.
Efficiency	Average arrestance > 90% when tested in accordance with BS:6540/ASHRAE 52-76 / EN-779.
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.
General	• A neoprene sponge rubber sealing shall be provided on either face of the filter frame. • Capable of being cleaned by air or water flushing. • Filter media shall be fire retardant and resistant to moisture, fungi, bacteria & frost.

7.2.11 FLEXIBLE DUCT

Semi rigid PVC ducting to be provided with 150/75/50 mm pitch spiral spring steel wire reinforcement of suitable wire diameter. The duct shall have leak proof coupling with hooks etc and complete support structure as required. The duct shall be suitable for sustaining 240 mmWC of static pressure. Ducting shall be as per IS-3768. The ducting shall be Flame resistant and Anti Static.

7.2.12 CYCLONE SEPERATOR

The contractor shall supply cyclone separators in raw water circuit to achieve the cleanliness of water to suit the HVAC system water requirement. The material of the cyclone separators casing shall be of stainless steel (316 or better). The separators shall be of continuous duty type with flanged inlet and outlet for use with raw water pumped from tail race. Individual separators shall preferably be capable for removal of all material as small as 75 microns with the efficiency of 98%. The cyclone separator casing shall be designed for minimum Schedule 80. Bolting type lower and upper half of cyclone separator is preferable in view of maintenance aspects. The separators shall be complete with purge valve and controls for automatic continuous operation.

7.2.13 VALVES

Gate Valve		
S. No.	**DESCRIPTION**	**DETAIL**
1	Size Range	50 MM & above, suitable for horizontal and vertical installation
2	Design Code	IS: 14846 or BS : 5150
3	Pressure Rating	a) PN 1.0 (as per IS:14846) b) PN 10 (as per BS:5150)
4	Construction Features	
4.1	Stem	Outside screw and yoke type, rising stem
4.2	Ends	Flanged, ANSI B16.5 Cl 150 (minimum)
4.3	Bonnet	Bolted
4.4	Wedge	Solid Wedge
5	Operation	by handwheel (Gear reduction unit for valve size 200 NB and above wherever applicable)
6	Seat	
	a) Body	Renewable
	b) Disc.	Renewable
7	Material of Construction	

7.1	Body/Bonnet/Handwheel	Cast Iron to IS:210 FG-200
7.2	Wedge Gland	Cast Iron to IS:210 FG-200
7.3	Stem	S.S. 410
7.4	Body Seat	GM to IS:318 Gr.-2
7.5	Wedge Seat	GM to IS:318 Gr.-2
7.6	Packing	Non-Asbestos
7.7	Back Seat Bushing	GM to IS:318 Gr.-2
7.8	Bolts, Nuts, & Studs	Carbon Steel to IS:1367, CL – 4.6/4.0
8	Accessories	• Position Indicator
		• Draining arrangement for Valve Seat
		•Locking Facility with lock
		•Gear reduction unit for valve size 200 NB and above.
		• Companion flanges, nut, bolts, washers
		• Limit switch for open and close status of valve at DDCMIS
Globe Valve		
S. No.	**DESCRIPTION**	**DETAIL**
1	Size Range	50 MM & above, suitable for horizontal and vertical installation
2	Design Code	BS : 5152 / Equiv.
3	Pressure Rating	PN 10 (as per BS:5152)
4	Construction Features	
4.1	Stem	Outside screwed & rising spindle
4.2	Ends	Flanged, ANSI B16.5 Cl 125 / Cl. 150
4.3	Bonnet	Bolted
4.4	Wedge	Solid Wedge
5	Operation	by handwheel (Gear reduction unit for valve size 200 NB and above wherever applicable)
6	Seat	
	a) Body	Renewable
	b) Disc.	Renewable
7	Material of Construction	
7.1	Body/Bonnet/Handwheel	Cast Iron to IS:210 FG-200
7.2	Wedge Gland	Cast Iron to IS:210 FG-200
7.3	Stem	S.S. 410
7.4	Body Seat	GM to IS:318 Gr.-2
7.5	Wedge Seat	GM to IS:318 Gr.-2
7.6	Packing	Non-Asbestos
7.7	Back Seat Bushing	GM to IS:318 Gr.-2
7.8	Bolts, Nuts, & Studs	Carbon Steel to IS:1367, CL – 4.6/4.0

8	Accessories	• Position Indicator
		• Draining arrangement for Valve Seat
		•Locking Facility with lock
		•Gear reduction unit for valve size 200 NB and above.
		• Companion flanges, nut, bolts, washers
		• Limit switch for open and close status of valve at DDCMIS
Check Valve (below 50 NB)		
S. No.	**DESCRIPTION**	**DETAIL**
1	Size range	Below 50 NB
2	Design Code/rating	IS : 778
3	Type	Swing check type
4	Pressure Rating	a) PN 1.0 (as per IS:5312) b) PN 10 (as per BS:5153)
5	End connection	Screwed ends ANSI B16.5
6	Material Specifications	
	a) Body, cover, flap, hinges	GM to IS:318 Gr.2
	b) Hinge pin, door pin	HT Brass
	c) Body seat ring, Disc. facing ring	As per OEM
	d) Gaskets	As per OEM
Check Valve (50 NB and above)		
S. No.	**DESCRIPTION**	**DETAIL**
1	Size range	50 NB and above
2	Design Code/rating	IS : 5312/ BS:5153
3	Type	Swing check type
4	Pressure Rating	a) PN 1.0 (as per IS:5312) b) PN 10 (as per BS:5153)
5	End connection	Flanged to Class 150 min
6	Material Specifications	
	a) Body, cover, flap, hinges	Cast Iron IS:210 Gr. FG.200
	b) Hinge pin, door pin	SS
	c) Body seat ring, Disc. facing ring	GM to IS:318, LTB 2
	d) Gaskets	Non-Asbestos
Butterfly Valve		
S. No.	**DESCRIPTION**	**DETAIL**
1	Size Range	50 MM & above, suitable for horizontal and vertical

		installation
2	Design Code	Double flanged or lugged wafer type of low leakage rate confirming to AWWA C-504/BS:EN:593/API 609/equivalent
3	Pressure Rating	PN 10
4	End Connection	Flanged as per ANSI B.16.5 Class 125 / BS-EN 1092
5	Material of Construction	
5.1	Body & Disc	Cast Iron
5.2	Shaft	SS 410 / SS 420
5.3	Seat Rings	EPDM
6	Accessories	• Position Indicator
		•Locking Facility with lock
		•Gear reduction unit for valve size 200 NB and above.
		• Nut, bolts, washers
		• Limit switch for open and close status of valve at DDCMIS
Balancing/Controller valve (32 mm to 50 mm dia)		
S. No.	**DESCRIPTION**	**DETAIL**
1	Material of Construction	Gun metal / cast iron construction with screwed ends.
Balancing/Controller valve (65 mm and above)		
S. No.	**DESCRIPTION**	**DETAIL**
1	Material of Construction	cast iron construction with internal parts of SS 410 and EPDM / nitrile seat with flanged ends

8. INSULATION

Thermal Insulation

AC ducts & Ventilation ducts (Carrying AHU supply air & Fresh air ducts inside Powerhouse/Transformer GIS cavern) shall be insulated as tabulated below.

Cooling water piping supplying cooling water to AHUs and discharge piping till tail race shall be insulated as Tabulated below.

Thermal Insulation

S. No.	Surface	Insulation Material	Insulation Form	Thick (mm)	Finish
1.	Supply air duct of Ventilation System and AC system.	Closed cell Elastomeric Nitrile Rubber. (Thermal conductivity 0.036 w/m/°C at 20°C, Density 40-60Kg/m^3)	Sheet	19	As per Manufacturer Standard

2.	Cooling water piping	Rigid Polyurethane Foam (Thermal conductivity 0.03 w/m/°C at 50°C, Density 32-36Kg/m3) Code: IS12436	Pipe Section	50	1.Insulation shall be covered with 500g polythene with 50mm overlap and sealing of overlap with synthetic adhesive like CPRX/ Loid Bond 83 or Equivalent compound. 2.The polythene shall be covered with 26-gauge Aluminium sheet and locking of joints with self-locking screws at a pitch of minimum 100 mm.

Acoustic Insulation

a) All ducts up to a distance of 5 meters from AHU shall be acoustically lined from inside with 25 mm thick resin bonded glass wool of 48 Kg/Cu.M. density and 30-gauge perforated aluminium sheet having 5 mm dia perforation at 8 to 10 mm centre to centre distance. Insulation shall be fixed on wooden frame of 600 x 600 mm dimension.

b) Fibre glass tissue sheet shall be applied over the outer surface of insulation before applying perforated aluminium sheet. Application of acoustic insulation shall be in line with the requirements specified above.

9. CONTROL PHILOSPHY

AC & Ventilation system of Power House & GIS/Transformer Cavern shall be PLC based control. Control Panels shall be placed at 1052.0M EL of Control Block.

One no. HVAC SCADA/PLC shall be provided for all control and monitoring operation of entire

HVAC system. This control panel shall be located in Control Room/EL 1052.0M E. All HVAC MCCs shall have an interfacing with HVAC SCADA/PLC only. The HVAC system shall be equipped with a fully independent automatic control system for efficient operation having automatic mode and manual mode. Signals from MCC shall be wired to PLC for drives. Further control logic shall be built into the PLC.

Al sensors and instruments, pressure switches etc. shall be provided for automatic regulation and monitoring of the system.

Power required for all sensors, three-way control valves, motorized dampers and all other peripheral devices shall be derived from respective MCC panel

The control system shall be equipped with the necessary control, interlocking and security devices. Any failure or breakdown in the HVAC equipment and control system shall be indicated by a signal on the respective PLC.

Necessary potential free contacts shall be taken from Fire Alarm panel to HVAC SCADA/PLC for performing automatic operation in case of fire.

The list of parameters to be monitored controlled shall be provided during detail engineering.

There shall be MODBUS communication between HVAC PLC & SCADA. Necessary/ critical remote indication of the alarms / fault / healthy / normal conditions in the Plant SCADA system shall be provided.

Control of fans placed at ventilation blower room outside CVT portal shall be through relay-based local control panel.

10. POWER SUPPLY ARRANGEMENT

The power supply (rated voltage, frequency, phase) of the equipment will be 415V +/- 10%, 3ph, 50 Hz +/- 5% or 240V+/- 10%, 1ph, 50 Hz +/- 5% as the case may be.

11. ACCEPTANCE TEST

a. **Air conditioning system:** Room condition test shall consist of taking the reading of dry bulb and wet bulb temp at different locations points to be mutually decided at site in the areas which are air-conditioned by the respective system/plant. Room condition test shall be done after stabilization of the system. The dry and wet bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with a least count of 0.5 degC. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer during month April to June when the dry bulb temp is generally high and during. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage. Relative humidity shall be determined from psychometric chart

b. **Ventilation system:** Temperature test at the out let of AHU and at different floors at mutually agreed locations. The dry bulb temp shall be measured by sling psychrometer which will have accuracy of +/-0.5% with a least count of 0.5 deg C. This will be carried out for 24 hrs continuously and readings will be taken every two hours. Standby equipment should be changed over during these 24 hours. This test shall be carried out during summer between months April to June. The format for recording the readings shall be defined in PG / Demonstration test procedure during detailed engineering stage.

c. All shop testing and test at site as specified shall be carried out.

d. The Noise level shall be as mentioned in specification.

Acceptance Test to be covered separately and should cover followings;

1. Performance Testing (Air Quantity at various floors)
2. Air Balancing
3. Leakage
4. Noise level
5. Vibration level
6. Fire Dampers working
7. Interlocking with control system.
8. Motor Current
9. Temperature/Humidity at various location of different floors
10. All equipment (fans, blowers, motors, Compressors, Pumps, heater etc.) checking

12. GENERAL

1) Basis of design, all calculations including heat load calculations for summer, winter 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 by Vendor.

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 elsewhere in the specifications; however, these equipments / items shall be subject to Customer & BHEL approval during detail engineering Stage.

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

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

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

10) Only calibrated instruments shall be used by HVAC supplier for testing of various equipment.

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

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

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

14) 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%.

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

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

- Design dry bulb temperature and relative humidity of conditioned air, Vibration and noise level etc.
- All calibrated instruments to be used for the tests at manufacturer's works/site shall be arranged by the bidder.

17) 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.

18) 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.

19) 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.

20) 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.

21) 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.

22) 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.

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

24) 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.

25) HVAC plant supplier to furnish drawings/ documents as per the dwg. / documents distribution as per project requirement.

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

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

28) The bidder shall furnish complete tech. Particulars in data sheet and schedules as specified elsewhere in the specification during detailed engineering.

29) The bidder shall arrange to provide training on complete HVAC system including operation & Maintenance for Employer Personnel.

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

31) Construction of openings in brick-walls, as required, for routing the ventilation, Air conditioning ducts and installation of axial fans, Louvres, dampers shall be in bidder's scope of works. Floor openings, as available at site, for duct routing can be used by bidder during erection of duct.

32) Further, sealing of duct opening, finishing of openings for ducts, axial fans, dampers, louvres, piping, cable trays, grouting of foundation / foundation bolts including special type of grouting like GPX2 etc. are in the scope of HVAC system supplier.

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

14.0 EXCLUSIONS

Items of works listed below are excluded from scope of the HVAC plant supplier.

a) Construction of HVAC plant room, air handling unit room, foundations for HVAC equipment.

b) False ceiling, drop ceiling

c) Provision of drain traps / points

15.0 Codes and Standards

Design, manufacture, inspection and testing of the equipment covered by the specification shall conform to the latest edition of the standards and codes of HVAC system.

SECTION: I

SUB-SECTION: C2-A

CUSTOMER SPECIFICATION

(TECHNICAL REQUIREMENT)

SECTION – 25
VENTILATION SYSTEM

25.1 SCOPE

25.1.1 This technical specification covers design, manufacture, assembly, inspection and testing at manufacturer's or his sub-contractor's works before dispatch, transportation, insurance & delivery FOR project site in Uttrakhand, unloading / handling , storage and preservation at site, complete work of site assembly erection, testing , commissioning and remedial action, if any, upto defects liability period of equipment for Ventilation systems for Vishnugad Pipalkoti HEP covering areas such as Power house cavern, Transformer cavern, GIS floor, Main Access Tunnel, Cable Tunnel, Service Building, Dam galleries etc. including 0.415 kV Motor Control Centers (MCC), central control and annunciation panel, control boxes for local / remote control of ventilation systems, Butterfly Valve House etc. The ventilation system shall comprise of supply air & exhaust air fans, back draft dampers, air filters and air washers to effect cooling, Aluminium grilles / diffusers, fitted with volume control dampers, motorised dampers, galvanised sheet metal ducts, acoustic lining insulations and supporting steel frame work structure for air supply & exhaust ducting system of the complete power house complex including supplying fresh air to air conditioned area. The scope of work also includes:

a) Additional tunnels other than shown in Layout Plan of the project area and Minor civil works such as fixing of anchor bolts, hangers and air ducts, sealing of wall openings after air ducts are put in position, erection of panels, motors and hardware's required for the civil works.

b) All the works which are required to install the ventilation system but not included in the specifications are also deemed to be in the scope of the supply. The bidder shall mention these items in the bid.

c) The bidder shall co-ordinate with concerned agencies of the power house for erection and commissioning of ventilation system.

d) All power cables from MCC to electric motors and control cables to the devices stipulated by this technical specification, as well as cables to the common control and annunciation panel envisaged in the computerised control room, cable trays, conduits, supports and all accessories for cables including laying of power and control cables on cable trays and their termination on MCC and panels are

covered in the scope of supplies of this technical specifications.

25.1.2 The scope of supply shall include special tools and tackles, spare parts, all relevant drawings, data and instruction manuals.

For complete scope of work kindly refer Sub-scetion C1 of Technical Specification.

25.2 DESIGN CONDITIONS

25.2.1 Outdoor Temperature & Humidity Conditions

Maximum temperature = 31^{0}C
Minimum temperature = 0^{0}C
Maximum Relative Humidity = 95%

Additionally refer Sub-scetion C1 of Technical Specification.

25.2.2 Indoor Temperature & Humidity Conditions Desired

For areas of power house served by ventilation system

Maximum temperature = (25-28^{0}C)
Maximum Relative Humidity: - 65 %
Bidder must refer to General Technical conditions specification for the actual site conditions. Those conditions would prevail for design of all systems.

25.3 STANDARDS

25.3.1 All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian / International Standards, Indian Electricity Rules / Act and other applicable statutory provisions. The equipments shall comply in all respects with the latest issues of the following standards except wherein specified otherwise.

i)	IS: 4720	Code of practice for ventilation of surface hydel power stations
ii)	IS: 3103	Installation, operation, testing and maintenance of ventilation system
iii)	IS: 4894	Centrifugal fans
iv)	IS: 2312	Propeller type AC ventilating fans
v)	IS: 1822	AC motor starters of voltage not exceeding 1000 volts
vi)	IS: 655	Specification for metal air ducts
vii)	IS: 4029	Guide for testing of three phase induction motor
viii)	IS: 900	Induction motor installation and maintenance code of practice
ix)	IS: 277	Specification for galvanised steel sheets
x)	IS: 325	Induction motors
xi)	IS: 3589	Electrically welded steel pipes

xii)	IS: 3588	Specification for electric axial flow fans
xiii)	IS: 7613	Air filters for air conditioners and ventilation-tests
xiv)	IS: 737	Specification for wrought aluminium or aluminium alloys sheet and strip
xv)	IS: 661	Code of practice for insulation.
xvi)	BS: 2831	Methods of test for air filters used in air Conditioning and general ventilation
xvii)	BS: 3928	Sodium flame test for air filters (other than for air supply to I.C. Engines and Compressors
xviii)	IS: 3069	Glossary of terms, symbols and units relating to thermal insulation material.
xix)	IS: 4671	Expanded polystyrene for thermal insulation purpose.

25.3.2 Equipment meeting with any other authoritative standards which ensure an equal or better quality than the standards mentioned above is also acceptable. However, the salient points of differences between the standards opted and the standards specified shall be clearly brought out in the bid. The bidder will submit copies of the applicable standards after the award of work. Standards and codes being followed may be listed.

25.4 DRAWINGS ENCLOSED WITH THE SPECIFICATIONS

25.4.1 The proposed Power house layout, cross section & various plans are enclosed in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement".

Refer Sub-section II for tender drawings.

25.4.2 The bidder shall examine the scheme & requirements given in the specifications/drawings and may furnish his proposals meeting the requirements of this specification for the consideration of the purchaser. Deviations, if any, from the specifications /drawings shall be communicated by the Bidder.

25.5 DESIGNING OF VENTILATION SYSTEMS AND ELIGIBILITY CRITERIA OF THE BIDDER

25.5.1 These specifications and drawings for the ventilation systems define the design criteria and main requirements to be met by the offered equipment.

25.5.2 The bidder shall design the ventilation systems based on requirements of the specifications and shall select the respective equipment for the ventilation systems best suited for the operation in tropical and humid conditions.

25.5.3 After the award of the contract, the supplier shall submit computations and drawings according to the conditions laid in the contract. The finalized technical data shall include appraisal of heat losses, dimensions of air ducts, as well as type and performance characteristics of the equipment.

25.5.4 The bidder shall submit to the purchaser for his approval catalogues and booklets with description of material and equipment, as well as design reports on operation of the systems and schedule of supplies and services including assembly and commissioning alongwith bid.

25.6 EQUIPMENT AND MATERIALS

25.6.1 Centrifugal Fan

25.6.1.1 General

The fans shall be supplied complete with electric motors, drives, starters, controls, protection measuring instruments, ammeter and voltmeter and accessories complete in all respect. The impellers shall be shop-balanced. The fans shall be provided with vibration absorbers. The fans shall be fabricated from carbon steel.

25.6.1.2 Design

The fans shall be provided with anti vibration pads for ensuring a reasonable degree of silence. Maximum speed of the fan preferably shall not be more than 500 rpm so that maximum noise level generated by fans is not more than 60 decibels inside the blower rooms. Necessary means shall be provided to prevent the entry of moisture inside the fans. The fans shall be designed for optimum performance at a given duty. However, it should be capable of working reasonably over a range of pressure and volume. The fans shall be designed for the static pressures suitable for site conditions.

25.6.1.3 Scroll

The casing shall be of welded construction, fabricated with heavy gauge material. It shall be rigidly reinforced and supported by structural angles and seams shall be permanently sealed air tight. Casing shall be provided with drain valve, if required.

25.6.1.4 Impeller

The impeller shall have die-formed blades welded to a rim and back-plate. Inlet shall be spun to have a smooth contour. Shaft

sleeves shall be provided, if required. The impeller, pulley and shaft sleeves shall be fastened to the shaft by keys & nuts. The impeller shall be statically and dynamically balanced.

25.6.1.5 Bearings

The bearings may be ball, roller or sleeve type and shall be adequately supported. They shall be easily accessible and lubricated properly.

25.6.1.6 Inlet, Inlet Guard

Inlet shall be spun to have a smooth contour. Inlet screen, if provided, shall be of galvanised wire of 25 square mm.

25.6.1.7 Base Plate

Base plate with necessary number of spring type anti vibration pads shall be provided.

25.6.1.8 List of accessories to the fans as provided shall be furnished with the bid with item-wise prices.

25.6.1.9 Fan Motor Drives

When belt drives are used, they shall be of the multiple V-belt type. Each drive shall consist of a cast iron fan pulley, cast iron motor pulley, endless rubber and fibre 'V' belt of suitable thickness. Pulleys shall be accurately proportioned so that the fan will be driven at the correct speed. The pulleys shall have proper number of grooves for V-belts, statically and dynamically balanced and bored, fitted and keyed to their respective shafts.
Where direct drives are employed with flexible coupling, the same shall be rugged in construction and suitable for its application. It shall be carefully fitted and secured to the fan and motor shaft. A removable metal guard of substantial construction shall be provided for each flexible coupling. The guard shall adequately protect the operator and others from contacts with the coupling. Suitable drive guard shall be fitted to fans. These guards shall be designed to allow adequate ventilation and to permit the measurement of shaft speeds without its removal.

25.6.2 Induction Motors

25.6.2.1 Performance and characteristics

a. Fan motors shall be of totally enclosed type and shall conform to latest version of IS-325. The motors shall be suitable for operation at 415 V and 50 Hz, three phase

supply with variation as given below. Motors shall be capable of giving rated torque and output without reduction in the expected life span when operated continuously under the following supply condition.

i)	Variation of supply voltage from rated motor voltage	±10%
ii)	Variation in supply frequency from rated frequency.	±3%
iii)	Combined voltage and frequency variation	±10%

b. Motors shall be suitable for full voltage direct on-line starting upto 50KW output and beyond 50KW it will be suitable for reduced voltage starting. The necessary starting system and their control and protection from local and remote control shall be provided.

c. Motors shall be capable of starting and accelerating the load with the permissible voltage and frequency variations under the applicable method of starting, without exceeding acceptable winding temperature limits.

d. The locked rotor current of the motor shall not exceed 600% of full load current.

e. Motors shall be designed to withstand 120% of speed for two minutes without any damage.

f. The motor vibrations shall be within the limits specified in applicable standard.

25.6.2.2 Insulation:

a) Any joint in the motor insulation such as at the connections or between slot and winding shall have strength equivalent to that of the sections of the coil.

b) The insulation shall be of class F and suitable for humid climatic conditions, tropical and water resistant for successful operation of the motor. The tropicalising treatment shall be as per the applicable standards.

25.6.2.3 Temperature Rise

The insulation of winding of motor shall be class F and the temperature rise shall not exceed 90^{o} C over an ambient temperature of 38^{o} C.

25.6.2.4 Constructional Features

The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of motor for inspection and repairs.

Motors shall be provided with eye bolts, lugs or other means to facilitate safe handling.

Horizontal motors shall be foot mounted type unless otherwise specified.

When the motor is supplied with driven equipment including a common base (bed plates, channels etc.), the bidder shall ensure that such bed plates are adequately braced to keep vibrations and misalignment within limits specified in the relevant standards.

25.6.2.5 Bearings

a) Greased ball bearings or greased roller bearings shall be of reputed make subject to the purchaser's approval. The life expectancy of the bearings shall be stated in the bid.

b) Construction of bearings shall be such that the loss of grease is kept to a minimum and greasing shall be possible without any dismantling operation.

c) The bearings shall prevent dirt and water from getting into the motor. Bearing lubricant shall not find access to motor windings.

d) The bearings shall permit running of the motor in either direction of rotation.

e) Unless otherwise approved, bearing lubricating system shall be such that no external force or water is necessary to maintain the required oil supply or keep bearing temperature within design limits.

f) Lubricants shall be selected for prolonged storage and normal use of the motors in tropical climate and shall contain corrosion and oxidation inhibitors. Grease shall have suitable bleeding characteristics to minimise setting.

g) Sleeve bearings for use with motors having flexible couplings with limited end play, shall have adequate axial end play to permit assembly so as to prevent transmitting of thrust from driven equipment to motor bearings.

25.6.2.6 Terminal Box

a) Terminal boxes shall be of weather proof construction designed for outdoor services to eliminate entry of dust and water. Gaskets of neoprene or approved non-aging type rubber equivalent shall be provided at cover joints and between box and motor frame.

b) The terminal box shall be suitable for top and bottom entry of cables.

c) Unless otherwise approved, the terminal box shall be capable of being turned through 360 degree in steps of 90^{o}.

d) The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances.

e) Suitable cable glands and cable lugs shall be provided.

f) Sizes of terminal boxes and lugs shall be as per applicable Indian standards.

25.6.2.7 Paint and Finish

Motor external parts shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased. All rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint. The motor fan shall also be similarly painted to withstand corrosion.

25.6.2.8 Space Heaters

Space heaters will be provided on each motor for heating and elimination of any condensation of moisture during idle conditions.

25.6.2.9 Accessories

a) Two independent earthing points shall be provided on opposite sides of motor for connection with the purchaser's earthing mat. These earthing points shall be in addition to earthing stud provided in the terminal box.

b) Except when otherwise specified, the motor shall be provided with a bare shaft extension having a key slot at the driving end.

c) When the motor, coupling and fan etc. are supplied by sub vender driven equipment bidder, the motor bidder shall strictly adhere to the dimensional requirements and other related to accessory for proper matching of these parts. All control and power wiring, cable support system, etc. shall be provided by the supplier.

25.6.2.10 Tests

Motor shall be subjected to all the routine tests as per applicable standard in the presence of the purchaser's representative. Copies of test certificates of type and routine tests, as specified in the relevant standard shall be furnished for the Purchaser's approval after award.

25.6.3 Filters

25.6.3.1 **Fibre Type**

Filter medium shall consist of a suitable fibrous material (e.g. coir, extruded sections of polyethylene etc) packed into a frame of galvanised sheet steel of 20 gauge thickness. Filter element shall be supported by galvanised steel wire mesh of 15 square mm on either side. Filter frames shall be provided with suitable handles.

25.6.3.2 Air velocity across the working section of filters shall be up to 3.0 m/s. The filters shall be able to remove particles 80% down to 20 microns and shall be cleanable type with compressed air.

25.6.4 System of air ducts

25.6.4.1 The system of air ducts shall consist of:

a) Air-intake grills wire mesh installed at inlet of ventilation tunnel / filters for outdoor air to blower room housing ventilation fans
b) Air duct at suction of fans;
c) Flexible inserts connected directly to suction opening of ventilation plant and air duct at air suction;
d) Flexible inserts connected to exhaust opening of ventilation plant and pressure air duct;
e) Check valve (or, back draft damper) arranged on pressure air ducts after each ventilation plant;
f) Pressure air duct running from ventilation plant to the premises to be ventilated.

25.6.5 Air ducts

25.6.5.1 General

a) Air ducts shall be air tight and smooth inside. The air ducts shall be securely fixed to structural elements and shall be vibration-free.
Air velocity in the main air ducts (ventilation tunnel) shall be taken as per relevant international/ national standards.

b) Air duct elbows shall be fabricated with a radius 1-2 times air duct diameter. The air ducts, elbows, dampers etc shall be fabricated from galvanized steel.

c) The thermometers and pressure gauges shall be installed on air ducts behind fans.

d) The air ducts which are to be embedded into concrete shall be fabricated from electric welded steel pipes of medium duty which shall be securely anchored to concrete or angular iron frames shall be provided wherever the ducts crosses the walls, slabs & opening etc..

e) All support system such as Angle iron, clamps, fixtures and hangers etc. to be used for ducts supports shall be included in the offer. The brackets and supports shall preferably be of adjustable type to ensure proper alignment of ducting. They shall be of strength sufficient to ensure that the duct will remain rigid. The drilling in rock/slab/walls etc. and providing and fixing/embedding of anchors etc. for supports is also included in the bidder's scope of supply.

f) Ducting over false ceiling shall be supported from the slab or beam or wall or rock. In no case, duct shall be supported from false ceiling hangers or be permitted to rest on false ceiling.

g) The proposed routing and sizes of the complete duct work (fresh air, supply air, return air) shall be based on space constraints due to layout of other equipment shown in various drawings of this bidding document. The bidder shall check the duct cross-sectional area as per his design practice and minor changes, if any, proposed by the bidder can be accepted by the purchaser.

h) Wall thickness for rectangular air ducts with maximum side dimensions:

Up to 750 mm	0.6 mm	(Gauge 24)
751 – 1500 mm	0.8 mm	(Gauge 22)
1501mm & above	1.0 mm	(Gauge 20)

i) Ducts can also be joined with hot dip galvanised nuts and bolts. A good quality of uniform thickness and width shall be used for sealing the flanged joints. The felt shall be fixed by a suitable adhesive and holes be made by passing a heated rod through it.

j) The ventilation supply & exhaust air ducts to be installed in the fire hazardous areas such as transformer chambers, insulating oil and lubricating oil plant rooms shall be covered with a suitable thickness of fire resistant board (e.g. calcium silicate board) so as to withstand damage due to fire for a period of minimum 60 minutes.

25.6.5.2 Material Requirements

The rolled steel sheet before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks and zinc coating on the steel shall not be less than 275 gms/sq.m as per the IS-277-1992 or its latest revision.

The aluminium sheets shall be of grade SIC or NS3 and shall be suitable for grilles / duct fabrication work as per IS-737-1965 or its latest revision.

25.6.5.3 Construction Features

The thickness of sheets, the type of bracings and other fabrication details shall be as mentioned in the forthcoming various clauses. The seams on duct may be continuous welded or grooved longitudinal seam. Ducts may be joined together in one of the following ways: By welding
The ducts shall be swedged 40mm from the ends so that the larger end will butt against the swedge and are held in place with sheet metal screws. Where the swedges are not used, the joints shall be pasted with asbestos papers to ensure a tight joint.

25.6.5.4 Duct Supports

Air ducts (rectangular & circular) shall be supported on steel structure comprising MS rods and MS angles of suitable size. The MS rods and angles shall be given a coat of primer paint. The duct supports shall be at a distance of not more than 1800 mm. The MS rods shall be hung from building steel with

provision of necessary auxiliary or special steel members or by hooks fixed to the ceiling slab. Auxiliary or special steel members, hooks, screws and all other supporting material required shall be provided by bidder. Wherever the ducts are thermally insulated, the MS angles and supports shall not be in direct contact with ducts.

25.6.5.5 Transformation and Branches

All curves, bends, off sets and other transformations shall be made for an easy and noiseless flow of air.

25.6.5.6 Caulking and Drain

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

25.6.5.7 Access Doors

Access doors shall be provided in the duct work or casing on both sides of the equipment to be serviced. All access doors shall be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be of built up construction, structurally strong and each shall have at least two hinges. Access doors shall have two rust proof window sash locks of approved type. All doors shall be set so as to flush with any insulation or plaster finish on the duct.

25.6.5.8 Vanes

All elbows shall be such that the throat radius is 75% of the duct width. In case the throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

25.6.5.9 Painting

Outer and inner surfaces of equipment for supply and exhaust ventilation systems as well as air ducts for D.C. battery room, acid room etc. shall have acid resistant coating to prevent deteriorating effect of sulphuric acid fume on the material of air ducts and equipment.

25.6.5.10 Acoustic Lining

Wherever it is essential to reduce the noise level of the fans to a comfortable limit the ducts shall be acoustically lined.

A noise level of not more than 60 db (A) shall be there inside the blower rooms & not more than 45 db (A) in all other rooms, measured at a distance of 1.5 m from any grille or diffuser. Silencers as required shall be provided by the bidder to guarantee the above noise levels.

25.7 INSPECTION AND TESTING

The ducts, branches, elbows, etc. shall be inspected and the joints & connections are to be checked before they are assembled in position. After assembly, the system shall be checked for tightness, vibration and noise.

25.8 BALANCING

The air distribution system shall be tested/balanced by bidder so that the requisite temperature and air flow are maintained throughout the space to be ventilated. Final balance of air quantities through each grille and diffusers shall be recorded and submitted to the purchaser for approval.

All instruments required for testing / balancing the air distribution system shall be provided by bidder.

25.9 FLEXIBLE INSERTS

The fans shall be connected to the air ducts through flexible inserts to preclude vibration transfer.

The flexible inserts shall be fabricated from glass cloth and shall be connected to the fans and air ducts with steel straps. The flexible inserts shall be minimum 120 mm long.

25.10 VENTILATION GRILLES & DIFFUSERS

25.10.1 The ventilation grills shall be fabricated from aluminium and finished with powder coating.

25.10.2 The air supply grills shall consist of adjustable flow deflectors permitting variation of air flow exit within 30° from the horizontal plane and air dynamic controller permitting variation of velocity and temperature coefficient values. The exhaust registers shall consist of a fixed front plate and motor controlled movable dampers.

25.10.3 The live section of the register shall be varied by moving the damper in horizontal direction. At full opening, the live section shall be minimum 66%. Wind velocity in plenum grilles shall be taken equal to 2-2.5 m/s and that in exhaust grilles as 3-3.5m/s

25.10.4 All the plenum chambers or connections to fans, dampers etc. shall be constructed in 18 gauge Galvanised Sheet Steel supported on 40x40x6mm MS angle frames. All vertical angle shall be riveted at approximately 125mm centers to the casing. Pecora or equivalent caulking compound shall be inserted between the base of angle and all masonry construction to which angles are fastened.

25.10.5 The type and quantity of diffusers and grills required shall be worked out by the bidder and detailed calculations shall have to be submitted for approval by

the purchaser. The supplier shall ensure that the diffusers/grills offered are of requisite capacity/throw and terminal velocity. The air pressure drop and the noise level shall be minimum / as specified. The diffusers/grills shall be approved by the purchaser.

25.11 AIR DAMPERS

25.11.1 The air dampers shall be fabricated from a 2 mm thick steel plate. The dampers shall have two flanges for their connection to the air ducts. The damper shall consist of shell housing a blade. The blade shall be moved manually or with electric drive mounted on a damper.

25.11.2 Every damper should be accessible and shall be provided with indicating / central as well as local & remote control device showing damper position.

25.12 PLENUM DAMPER (AIR FLOW CHECK DAMPER)

The plenum damper is intended to preclude air flow through the branch ducts to the shut off fans. The plenum damper consists of enclosure with two flanges. Inside the enclosure two half-axles mount a flap. Besides, one of the half-axles is counterweighted. The damper shall open at the air velocity ≥4 m/sec at the vertical stretches and ≥5 m/sec at the horizontal stretches. The damper flap shall be made of 1 mm thick steel sheet.

25.13 FIRE DAMPERS

The fire dampers shall be located in the ventilating openings of fire hazardous rooms. The damper shall be made of 2 mm thick steel sheet. The damper shall consist of enclosure with vanes and have two flanges for connection to air ducts. The vanes shall be operated by an electric drive to be mounted on the damper. The enclosure and vanes shall have flame retardant coating with fire withstand limit of 1 hr or shall be fabricated from material with fire withstand limit of 1 hr.

25.14 DILATOMETRIC THERMOSTATIC SWITCH

The thermostatic switch is intended for indication and two-position control of ambient temperature & shall be installed at the junction of MAT & service bay. The operation of 2/3 fans of system of M/c hall & Transformer Hall & opening of return air dampers in the four ventilation rooms located in Annexe floors of M/c hall & Transformer Hall shall be through this switch.

Its functioning is based on proportional change in the length of sensitive tube and rod due to change in the temperature of controlled medium. Change in the length converted into elastic deformation of the spring/stretching opens/closes the contacts.

Dilatometric sensitive element consists of sensitive tube and rod. The sensitive tube shall be fabricated from material having large coefficient of linear expansion.

The thermostatic switch comprises dilatometric element, contact device and setting adjustment.

25.15 POWER SUPPLY

25.15.1 The power supply to the various ventilation systems shall be arranged from motor control centers (MCC), located near respective ventilation system.

25.15.2 The fire preventing valves (i.e. fire dampers) shall be fed from the ventilation MCC.

25.15.3 The ratings of the equipment mentioned for MCC and size of power supply cables are tentative and shall be reviewed by the bidder based on the actual motor ratings offered as per this technical specification which will be got approved from the purchaser.

25.16 OPERATION REQUIREMENTS

25.16.1 The ON/OFF commands for ventilation systems of machine hall and transformer hall in remote mode of operation will be organized from the operating station, ventilation control and annunciation panel installed in computerized control room and in local mode from MCC or by push-buttons, located in ventilation chambers of different supply / exhaust air systems.

25.16.2 Non essential ventilating systems shall be operated only from MCC or push-button stations located at ventilating systems.

25.16.3 The ventilation systems of Butterfly valve chamber shall be operated in local mode from MCC or by push-buttons, located in the ventilation room.

25.16.4 One central ventilation control and annunciation panel shall be supplied for installation at Station Control Area (SCA) with control switches, alarm anunciators, ON/OFF position lamps, ventilation systems mimic diagram etc.

25.16.5 Engraved Mechanical Mimic Diagram shall be provided with aluminium / steel sheet. Ventilation systems position lamps shall be provided on mimic diagram.

25.16.6 The ventilation systems, which will serve and stand-by modes of operation, shall be provided with control board near ventilation system. Selector switches (service/stand-by), control switches, relays shall be provided with these control boards.

25.16.7 All other control functions, necessary blockings shall be organized into control modules of corresponding MCC.

25.16.8 The control boxes shall be installed at the fire dampers. The front face of the control boxes shall mount selector switches “Local/Remote” and push buttons “Open/Close”.

25.16.9 In the remote mode, the fire dampers shall get closed in case of fire in respective locations automatically & fans supplying exhausting air from / to the premises shall stop.

25.16.10 Provisions shall be made for entering “the fire dampers close” signal into the control boxes from the corresponding Fire Detection and Alarm Panels.

25.16.11 All wiring required to meet the above requirements shall be in the scope of supplier

25.17 OPERATION OF VENTILATING SYSTEMS

25.17.1 Outside Fresh Air Supply ventilation System. The operation requirement of fans is described in clause 25.38.1.

25.17.2 Ventilating System

Each supply and exhaust fan shall be provided with facility to operate in the main and stand-by modes of operation. The standby fan shall start automatically when the main fan shuts down.

These ventilating systems shall create positive air pressure during fire in the smoke-free stairway & lift shafts located at each end of machine hall & transformer hall. The system shall also operate intermittently at regular intervals during normal operation.

Therefore, besides the manual control from MCC, SCA and local control, necessary control for automatic start-up of the ventilating system to be initiated by the Fire Detection and Alarm Panel to be located in computerized control room shall be provided.

The supply and exhaust systems shall start simultaneously. Necessary control cabinet with respective selector switches and automatic relays to select the mode of fan operation shall be provided. The fans shall stop automatically on receipt of signal from fire detection & alarm panel.

25.17.3 Reversible air flow ventilation system. The operation requirements of the fan are described in clause 25.38.1.2.

25.17.4 Butterfly valve chamber Ventilating system

One fan shall run continuously. The stand by fan shall come automatically on line when the main fan stops.

25.18 MOTOR CONTROL CENTER (MCC)

25.18.1 MCCs installed for power supply and control of ventilation systems shall have following requirements.

MCC shall be indoor, air insulated, floor mounting and fully draw out type.

MCC shall be made as a cabinet with one side servicing.

MCC's should be supplied in accordance with the requirements specified in the technical specifications.

MCC may be fed power from two sources.

As MCC being fed power supply from two sources, it shall be provided with automatic change over unit.

Air Circuit / Moulded case circuit breakers (MCCB) shall be used in MCC as incoming and outgoing.

25.18.2 Incoming MCCB shall be provided with motor wound spring charging mechanism, shunt trip and switching coil and outgoing MCCB shall have manually operated spring charged mechanism.

25.18.3 All incoming feeders of MCC shall have a switch disconnector in the input of power supply with handle on compartment door. Alternatively, incoming feeders shall have rotary handle operating mechanism on compartment door.

25.18.4 All incoming feeders shall normally be energized. The two incoming circuit breakers of the MCC's shall be interlocked in such a way that only one of them can be closed at a time. Each of the two incoming feeders shall be locally selectable at the respective MCC as the primary feeder to distribute the load evenly. Automatic changeover unit will select a secondary feeder if the primary feeder loses power supply and back again when power supply is restored. Delay on automatic changeover shall be adjustable 0-10 s. The voltage control relays shall be provided with the necessary quantity of potential free contacts for specified indications, protection, control, alarms, supervision and interlocks.

25.18.5 Controlled outgoing feeders (motor starter units) shall be a draw-out combination of a circuit breaker and a contactor, relays, push buttons, lamps etc mounted in one cassette together with all other associated equipment.

25.18.6 Each MCC shall be provided with one spare MCCB for every rating included in this MCC.

25.18.7 One current transformer shall be provided for each incoming feeder. One voltage transformer shall be provided for measurement of busbar voltage. A moving-iron voltmeter with selector switch shall be located on the front panel, along with moving-iron ampere meters with selector switch for all incoming feeders.

25.18.8 Technical data and ratings of MCC

1.	Rated voltage	415 ± 10% V
2.	Frequency	50 ± 3% Hz
3.	Insulation level	2.5 kV for 1 min
4.	No. of Phase	3
5.	Neutral	Solidly grounded
6.	Rated current	2000 A– main, 630A
a)	of bus bar at	–
		Tap off.
	Moulded case circuit breaker	
		Up to 630 A
b)		
7.	Rated short time withstand current,	50 kA for 1 Sec.
8.	Cubicles	
	Type	Indoor, metal enclosed
	Cooling/ventilation	Natural
	Door	Hinged
	Protection class	IP 54
9.	MCC: Incoming circuit breakers	
	Circuit breaker type	Air circuit breaker / Molded case circuit breaker, draw out
	Operating mechanism	Motor wound spring charged
	Live parts cover	Automatic when withdrawn
	Operating mode	Local and remote(motor wound)
10.	MCC: Outgoing feeders:	
	Circuit breaker type	Moulded case circuit breaker
	Operating mechanism	Manually operated spring charged
	Feeder type	Draw-out cassette
	Live parts cover	Automatic when withdrawn
	Mode of operation of outgoing feeders	Local and remote
11.	Control Voltage –AC equipment	240V AC ±10%
12.	Service voltage – AC equipment	240V AC ±10%

25.19 CONTROL CIRCUITS

25.19.1 The control circuit supply voltage for incoming, outgoing and sectionalised circuit breakers shall be 240V AC.

25.19.2 Miniature circuit breakers shall be provided with an alarm contact for remote indication of tripped condition for protection of the control circuits. The miniature circuit breakers shall be of the fixed type for mounting on a DIN rail. All means shall be provided for easy removal and handling of the miniature circuit breakers.

25.19.3 All miniature circuit breakers shall be provided with the necessary quantity of potential free contacts for specified indications, alarms and interlocks. All auxiliary contacts shall be wired to terminal blocks in the cable compartment.

25.19.4 Auxiliary contacts shall be wired to terminal blocks for the following remote indications:

Circuit breaker trip conditions (common for each of MCC).
Ventilation systems ON position.
Malfunction at MCC (common for each of MCC).

25.19.5 Each controlled outgoing feeder unit shall be equipped with facility for remote operation, if it is not provided in the individual local control cubicles.

25.19.6 Each cassette unit shall be equipped with a local start-stop push button and an indicator showing the position of the contactor. All these devices shall be located in the unit compartment door.

25.19.7 The terminals shall be provided in one of the MCC cubicles to which all the signals from ventilation systems fed from this MCC shall be connected & then these signals by means of one or two cables shall be transmitted to computerised control room.

25.20 METERING

- All measuring equipment shall be located in the respective circuit breaker compartment.
- All metering circuits shall be terminated on marked terminal blocks for remote metering purposes.
- All meters, indicators, control and selector switches shall be located in the hinged door of this compartment.

25.20.1 Each MCC shall have

- One bimetal/moving-iron ampere-meter with selector switch on all incoming feeders;
- One voltmeter with selector switch for bus voltage;

25.20.2 Current measurements:

Current transformers shall be mounted in the compartment or cassette with their respective feeder.

Secondary leads of the current transformers shall be connected to marked terminals in the cable compartment in each cubicle. Secondary windings shall be earthed at one point only and means shall be provided on the equipment to facilitate the secondary circuits of the current transformers being short-circuited in the terminal blocks.

25.20.3 Voltage measurements

The secondary leads of the voltage transformer shall be connected to miniature circuit breakers with alarm contacts and wired to terminals. The secondary winding shall be earthed at one point only.

25.21 EQUIREMENTS FOR POWER, CONTROL AND INSTRUMENTATION CABLES 0.66 / 1.1 KV

25.21.1 All power cables from MCC to electric motors and control cables within the limits stipulated by this technical specification shall be included by the bidders in their scope of supply.

25.21.2 The scope of supply shall include, but not limited to the external measuring, control, signaling cables and their accessories, including the cables for remote control and annunciation panel of ventilation system.

25.21.3 The cables shall be heavy duty type and suitable for continuous operation under climatic conditions prevailing at the site, i.e. hot & humid tropical climate.

25.21.4 The cables shall have a termite, vermin, rodent-proof covering.

25.21.5 The cables shall be of fire-retardant and flame-retardant, low smoke (FRLS) type.

25.21.6 All AC power supplying cables shall have multi core/single core aluminium conductors and XLPE/HR-PVC insulation.

25.21.7 Flexible power cables shall be provided for connection of the motors as well as for the difficult laying conditions.

25.21.8 All control and instrumentation cables shall be multi core annealed high conductivity copper conductor solid or wire stranded type, insulated with HR-PVC insulation, PVC sheethed, conforming to IS 1554 (part I or II). The outer sheath shall be of specially formulated PVC compound.

25.21.9 All control cables (except for current circuits) shall have at least 20% or 1 spare cores whichever is more.

25.21.10 Control cables shall be standardized as much as possible in order to supply only a few different types (e.g. 4, 5, 7, 14, 19 and 27).

25.21.11 Control, annunciation's, secondary wiring shall be 650/1100 V grade, multi-conductor cables. Single conductor cables shall be used for short runs.

25.21.12 For the cables for pick-ups, for data transmission to remote panel in CCS and elsewhere the flexible cables are necessary. The conductors shall be plain copper, stranded wire type with PVC core insulation and shall have braided screen of tinned Cu or steel wires.

25.21.13 The cables for analog signals transmission to computers of Computerized Control System shall be 300 V grade screened twisted pair solid multi-conductor of 0.8 millimeter diameter.

25.21.14 The cables for outdoor installation and where mechanical damages are possible, shall have armouring. The armouring applied for cables over the inner sheath, can be of steel strips/tapes and shall conform to IS: 375.

25.21.15 The cables shall be capable of satisfactory operation under a power supply system having frequency variation of +/-3%, voltage variation of $\pm$10% and a combined frequency & voltage variation of 10% (absolute sum). The number of cores and sizes of the cables required for various circuits shall be as specified in the "Schedule of Requirements and Price Schedule".

25.21.16 The cables covered by this specification shall be supplied in one length or in standard length as approved by the purchaser.

25.21.17 To facilitate easy identification of phases a color scheme of Red, Yellow and Blue for phases and Black for neutral shall be adopted for power cables. Multi-core control cables shall be color coded for identification of cores as per IS:1554 - 1976.

25.21.18 Following color scheme shall be adopted:

single-core	Red, Yellow, Blue or Black
2-core	Red and Black
3-core	Red, Yellow and Blue
4 – core	Red, Yellow, Blue and Black
5-core	Red, Yellow, Blue, Black and Light Grey

Where the number of cores exceeds 5, two adjacent cores (counting core and direction core) in each layer are colored Blue and Yellow respectively, and the remaining cores are Light Grey.
Control cables with core identified by numbers also can be provided.

25.22 REQUIREMENTS FOR CABLE LAYING

25.22.1 All cables that shall be laid by the supplier shall be terminated at both ends. The supplier shall provide numbered ferrules at each connecting terminal in order to check connections without any difficulty. Terminal blocks have to be provided in various panels/equipment for these terminations. One termination shall mean connecting both ends of one core of a cable to given terminal blocks. The cables shall be terminated by crimping lugs to the ends.

25.22.2 It is also proposed to procure lugs corresponding to the cable sizes. These shall be made of copper tube electrotinned. The supplier shall ensure that no bimetallic action takes place, between the aluminium conductor of the cable and the cable connecting lug by filling the lugs with suitable compound.

25.22.3 The supplier shall supply and install all necessary cable trays and cable support systems complete with brackets, supports, hardware and special fittings for power and control cables in cable trenches, ceiling and ducts, etc. as specified herein or as approved by the engineer incharge. Special fittings shall include tees, wyes, bends crosses, dividers, reducers, dropouts, connectors and supports and all other materials required to form a complete cable tray system.

25.22.4 The power and control cables shall be run separately on racks/trays, in cable trenches/cable tunnels and on columns, walls, ceiling and pulled through pipes/conduits.

25.22.5 The bidder in his design shall give preference to the use of cable trays through out. Where this is not feasible because of space, cable supports may be used, subject to Engineer's approval.

25.22.6 The supplier shall be responsible for carrying out proper dressing of the cables and supply non magnetic/ moulded fiber glass cable fixing strips, fasteners and clamps, wherever necessary to hold the cables firmly to the trays.

25.22.7 Cushion type cable clamps shall be provided to hold the cables firmly on the steel supports without harming the cable insulation.

25.22.8 Cables shall be properly clamped at regular intervals with the help of non magnetic/molded fiber glass strip clamps/PVC sleeved clamps, of suitable size. Bidder shall submit typical drawings along with tender giving proposed clamping arrangement and also give distance of clamping at bends and in regular run of cables.

25.23 EQUIPMENT REQUIREMENTS.

25.23.1 Cubicles

25.23.1.1 Sheet Metal work

i) The frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2.5mm.

ii) Frames shall be enclosed by sheet steel of thickness not less than 2mm cold rolled or 2.5mm hot rolled, smoothly finished, levelled and free from flaws. Doors and covers shall be made of sheet steel of thickness not less than 1.6mm cold rolled or 2mm hot rolled. Stiffeners shall be provided wherever necessary.

iii) All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

iv) Cut-outs shall be true in shape and devoid of sharp edges.

v) The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

25.23.1.2 Constructional Features

i. MCC shall be of metal enclosed, indoor, floor mounted modular type and shall be made up of the requisite vertical sections of dust and vermin proof construction.

ii. Provided with a degree of protection of IP 54, easily extendable on both sides by the addition of vertical sections after removing the end covers.

iii. Provided with a metal sill frame made of structural steel channel section properly drilled for mounting the switchgear alongwith necessary mounting hardware. Hardware shall be zinc plated and phosphated.

iv. Provided with labels on the front and rear indicating the switchgear designation.

v. Provided with cable entry facilities at top/bottom with 3mm thick removable gland plates and necessary cable glands. For 1 core cables these plates shall be non-magnetic.

vi. Of uniform height of not more than 2150mm of single or double front execution.

vii. Provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors.

viii. Provided with bus-bars running at the top or bottom as required, all along the length of the switchgear in a separate sheet steel enclosure.

ix. Operation devices shall be incorporated only in the front of the switchgear.

x. The switchgear shall be divided into distinct vertical sections and each comprising of:

xi. A completely metal enclosed busbar compartment running horizontally.

xii. Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the base unit size to provide for flexibility in changes, if any, at site.

xiii. Enclosed vertical bus-bars serving all modules in the vertical section. For safety isolation of the vertical bus-bars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical bus-bars.

xiv. A vertical cable alley covering the entire height.

xv. The cable alley shall be minimum 200mm wide for motor controlled modules and 500mm wide for circuit breaker controlled modules.

xvi. A horizontal separate enclosure for all auxiliary power & control boxes as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

xvii. Each vertical section shall be equipped with space heaters which may be located in the cable alley.

xviii. One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.

xix. All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with hinged door.

xx. For draw-out type modules, only the handles of control and selector switches, push buttons, knobs & cut outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing.

xxi. Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

xxii. In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried

out in separate cable compartments for power and control cables.

xxiii. After isolation of the power and control connections of a circuit, it shall be possible to safely carry out maintenance in compartment with the bus-bars and adjacent circuit live.

xxiv. The withdrawable chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

xxv. Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carryout maintenance work on cable connections to any one circuit with the bus-bars and adjacent circuits live. Adequate number of slotted cable support arms shall be provided for clearing the cables.

xxvi. Rear of single front switchgear shall be provided with removable panels. It shall be possible for one person to remove and fix the removable panel.

xxvii. All doors shall be provided with concealed type hinges and captive screws.

xxviii. The withdrawable chassis housing circuit breakers shall be of the fully draw-out type.

xxix. The withdrawable chassis housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully draw-out type.

25.23.1.3 Fully draw-out type withdrawable chassis

In this type of construction it shall be possible to drawout the withdrawable chassis without having to unscrew and unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control drawout type connections shall be of the stab in or sliding type. All drawout contacts, including for auxiliary and control wiring shall be of self-aligning type.

25.23.1.4 Interchangeability

i. All identical equipment and corresponding parts including chassis of drawout modules of the same size shall be fully interchangeable, without having to carryout modifications. For trouble free interchangeability, the drawout arrangements shall be designed such that

normal dimensional variations are taken care of by self-aligning feature of the modules.

ii. Components of equipment that are not fully interchangeable are liable for rejection. Supplier shall replace all such equipment by fully interchangeable equipment at his cost.

iii. The drawout contacts shall be only between copper/copper alloy/ aluminium faces, which are silver or tin plated. The contact design shall be such that there shall be no arcing/deformation under the rated peak short circuit current.

iv. Switchgear shall be designed in such a way that all components of equipment and bus bars operate satisfactorily without exceeding their respective maximum permissible temperature rise limits under ambient temperature condition prevailing within the switchgear cubicle, with reference to ambient temperature outside the switchgear cubicles.

v. Bus ducts, if required for incoming circuits or for interconnecting switchgears, shall be supplied. The rating, material of the bus-bars and enclosure shall be same as the switchgear, unless otherwise specified.

25.23.2 Bus and bus taps

25.23.2.1 Switchgear shall be provided with three phase or three phase and neutral bus-bars as per the requirement and same shall be approved by the purchaser during details engineering.

25.23.2.2 Bus-bars shall be of uniform cross section throughout the length of the switchgear, and upto the incoming terminals of feeder circuit breakers/ switches.

25.23.2.3 The bus-bars shall be made of high conductivity aluminium alloy of E9IE grade.

25.23.2.4 Bus-bars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase system.

25.23.2.5 All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450V/mil) to provide a permanent high dielectric non-ageing and non-tracking, protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflamable and self-extingushing and in fast colors to

indicate phases. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0^{o} C. to 90^{o} C.

If the insulating sleeve is not colored but black, bus-bars shall be color-coded with colored bands at suitable intervals.

25.23.2.6 Bus-bars supports shall be adequately braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Bus-bar reinforced moulded plastic material, permal wood or cast resin.

25.23.2.7 Separate supports shall be provided for each phase of the bus-bars. If a common support is provided for all three phases, anti racking barriers shall be incorporated between each phase as well as for neutral.

25.23.2.8 Bus-bars joints shall be complete with high tensile steel bolts and spring washers and nuts. Bus-bars shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

25.23.3 Auxiliary Buses

23.23.3.1 Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses.

25.23.4 Control module

25.23.4.1 Moulded Case Circuit Breakers

i. Moulded case circuit breakers (MCCBs) shall be provided for the motor controls. The MCCBs shall conform to the latest applicable standards.

ii. MCCBs in AC circuits shall be of triple pole construction arranged for simultaneous three pole manual closing and opening and for automatic instantaneous tripping on short circuit. Operating mechanism shall be quick-make, quick-break and trip-free type. The ON, OFF and TRIP position of the MCCB shall be clearly indicated and visible to the operator when mounted as in service. Operating handle shall be provided in front of board.

iii. MCCBs shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings starting current and the mechanical stress caused by the peak short-circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 20 milliseconds.

iv. The instantaneous short circuit release shall be so chosen by the bidder as to operate at a current in excess of the peak motor inrush current and a range of setting shall be provided for the purchaser's selection.

v. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings.

vi. Under-voltage release and overload inverse time release shall be provided.

vii. Short circuit withstand capacity shall be 50 kA for 1 sec.

25.23.4.2 Contactors

- Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.
- Main contacts of motor starter contactors shall be of silver plated copper.
- Each motor starter contactor shall be provided with two NO and two NC potential free auxiliary contacts.
- Insulation class of operating coils shall be class E or better.
- Operating coils of contactors shall be suitable for operation from the 240V AC supply system.
- Contactors shall comply with all other requirements of applicable standards.
- Contactors shall be of the double break, non-gravity type.

25.23.4.3 Direct-on-Line Starters

Direct-on-line starters shall be suitable for class AC 3 utilization category as specified in applicable standards.

25.23.4.4 Automatic Star-Delta Starters

For motor capacity more than 50 kW, automatic star-delta starters shall comprise three sets of contactors, one for the line, one for the star point and one for the delta, and a timer relay to automatically change the connections from star to delta.

Star-delta contactors shall be electrically interlocked to permit starting of the motor in the proper sequence, namely star contactor closing, line contactor closing, energisation of timer, timer contact de-energizing the contactor and delta contactor closing.

Star-delta starters shall be suitable for AC 3 utilization category as specified in applicable standards.

25.24 SINGLE PHASING PREVENTERS

i.) Single phasing preventer relay shall be provided to protect motors against single phasing. The relay shall not operate for supply voltage unbalance of ± 5% but shall positively operate for supply voltage unbalance of more than ± 5%. The relay shall operate in the event of a single phase fuse blowing even though the motor emf in the concerned phase is of the order of 85%.

ii.) The relay shall be suitable for application to protect motors. The relay operation shall be independent of the motor kW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

25.25 INDICATING INSTRUMENTS AND METERS

- Electrical indicating instruments shall be of minimum 96mm square size, suitable for flush mounting.

- Indicating instruments shall have provision for zero adjustment outside the cover.

- Instruments dials shall be parallex free and provided with a suppressed extended scale to indicate motor starting current.

- Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current.

- Watt hour meters shall be of the direct reading electro-dynamometer type complete with cyclo-meter type dials and reverse running stops.

25.26 INDICATING LAMPS

Indicating lamps shall be of the filament type/LED, of low watt consumption provided with series resistors. These shall be provided with translucent lamp covers of colours red, green and amber.

Bulbs and lenses shall be easily replaceable from the front.

25.27 CONTROL AND SELECTOR SWITCHES

25.27.1 Control and selector switches shall be of the rotary type, adequately rated for the purpose intended (minimum acceptable rating is 10A continuous at 240V AC and inductive break 220V DC) and provided with escutcheon plates clearly marked to show the positions.

25.27.2 Control switches shall be of the spring return to normal type and provided with pistol grip type handles.

25.27.3 Control switches for circuit breaker control shall be provided.

25.27.4 Selector switches shall be of the maintained contact stay-put type. Switches in ammeter circuits shall have make-before-break type contact and provided with oval handles.

25.28 PUSH BUTTONS

25.28.1 Push button shall be of the momentary contact, push to actuate type rated to carry 10A at 240V AC with inductive breaking at 220V DC and fitted with self reset, 2 NO and 2 NC contacts. Push buttons shall be provided with integral escutcheon plates marked with its function.

- Start push buttons shall be green in color.

- Stop push buttons shall be red in color.

- All other push buttons shall be black in color.

25.28.2 Emergency stop push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

- Push button switches with a built-in indicating lamp shall be supplied.

25.29 ALARM ANUNCIATORS

- Alarm anunciators shall be installed at central ventilating control and annunciation panel in SCA as well as various MCCS.

- The alarm annunciation scheme alongwith complete wiring shall incorporate the following features:

- Visual indication of the fault by means of steadily lit alarm lights.

- Audible alarm on the occurrence of the fault.

- Red facia units to differentiate trip alarm from non-trip-alarms.

- Acknowledgement of occurrence of fault, incorporating audible alarm cancellation features.

- Resetting the scheme after the faults have been cleared.

- Facility to test the healthy condition of the lamps automatically excluding units indicating existing faults.

- Prevention of mal operation of the scheme when the push buttons are pressed incorrect or in a wrong sequence.

- Initiation of the complete sequence of audio-visual alarms in the event of a new fault occurring at the time of accepting an existing fault.

- Suitable for operation on a 2 wire, DC supply voltage with a supply voltage variation between 80% and 110% of the rated voltage.

- Suitable for operation for fleeting (15 millisecond duration) as well as the persistent faults.

- Facility for a separate audio-visual alarm to indicate alarm supply failure suitable for operation from a 2 wire, 240V AC supply.
- Facility for duplicating the audio-visual alarm in remote computerised control system room.
- The alarm annunciation scheme shall comprise the following equipment:
- A common alarm bell
- Accept reset and lamp test push buttons.
- Alarm supply failure, accept and reset push buttons.

25.30 SPACE HEATERS

Space heaters for switchgear and starter panels shall be suitable for operation on 240V AC provided with single pole MCB with overload, short circuit release and provided with thermostats to cut off the heaters at 45^{o} C.

25.31 CABLE TERMINATIONS

25.31.1 Suitable compression type, heavy duty brass cable glands with check nuts, rubber sealing ring and brass washers mounted on a removable gland plate shall be provided to support all power and control cables entering the MCC. Cable glands shall incorporate built-in facilities for earthing the wire armour of cables. Cable glands shall be plated to avoid corrosion.

25.31.2 Power cable glands and crimping type lugs shall be supplied to suit the cable sizes. Approximate quantity of control cable glands for different types of modules shall be indicated in the module drawing/bill of material. If during course of detailed engineering of the switchgear it is found necessary to provide more glands of higher size than those envisaged, the bidder shall provide and accommodate the same without extra cost.

25.31.3 For clamping cable cores at regular interval inside the cable alleys, suitable slotted angles, up to the respective terminal blocks, shall be provided.

25.31.4 Necessary crimping of tinned copper cable lugs for connecting the individual cores to the respective terminals shall be provided.

25.32 INTERNAL WIRING

25.32.1 Wiring inside the MCC and control panels shall be carried out with 1100/650V grade, PVC insulated, Stranded Aluminium conductor wires. Minimum size of conductor for power circuits is 4 sq.mm copper or equivalent size aluminium conductor. Control circuit shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits, 1.5 sq.mm. for other circuits & the number and size of strands shall be 7 of 0.67mm and 0.5mm diameter respectively.

25.32.2 Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow color with black lettering.

25.32.3 Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked T.

25.32.4 Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks. Wiring for equipment if supplied by the purchaser for which the supplier has to provide cut-outs (where indicated in the data sheets) shall be provided upto the terminal block. Spare and unassigned modules shall be complete with internal wiring.

25.32.5 Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts & washers/lock-nuts.

25.32.6 Not more than two connections shall be made on any one terminal.

25.33 TERMINAL BLOCKS

25.33.1 Terminal blocks (both for power and control circuits) shall be of reputed make specially for CT & VT circuits. It shall comprise finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and locknuts. The studs, shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

25.33.2 Terminals for circuits with voltage exceeding 125V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

25.33.3 Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

25.33.4 Terminals shall be numbered for identification. Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit.

25.33.5 Where duplication of a terminal block is necessary, it shall be achieved by solid bonding links.

25.33.6 Terminal blocks, CT secondary lead wires shall be provided with shorting and disconnecting/earthing facilities.

25.33.7 Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks. Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5sq.mm size. Screwless cage Clamp / Plug in type terminal block can also be considered.

25.34 LABELS

- All labels shall comprise white letters on a black background.
- Labels shall be made of non-rusting metal or 3-ply lamicoid, or engraved PVC.
- Labels shall be properly fixed, with provision to prevent distortion due to expansion.
- Size of lettering shall be 6mm, unless otherwise specified.

25.35 EARTHING

25.35.1 Each control cubicle shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified in data sheets. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the purchasers earthing conductor.

25.35.2 Earth busbars shall be supported at suitable intervals.

25.35.3 Positive connection between all the frames of equipment mounted in the switchboard and earth bus bar shall be provided by using insulated copper wires/bare busbars of cross

section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

25.35.4 All instruments and relay cases shall be connected to the earth busbar using 1100/650V grade, 2.5 sq.mm stranded, copper earthing conductor.

25.36 PAINTING

25.36.1 All sheet steel work shall be phosphatised in accordance with applicable standards.

25.36.2 Oil, grease, dirt and other adhesive foreign matter shall be thoroughly removed by emulsion cleaning.

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

25.36.4 After phosphatising, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

25.36.5 The phosphate coating shall be sealed by the application of two coats of zinc chromate primer. The first coat may be flash dried while the second coat shall be stoved.

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

25.36.7 Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

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

25.36.9 Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces. The color of the finish paint shall be approved by the purchaser during details engineering.

25.37 TECHNICAL PARTICULARS

Technical particulars shall be furnished along with bid as per Annex II&III. Any other information not covered herein may also be furnished.

25.38 DESCRIPTION OF VENTILATIING SYSTEMS

Cooling arrangement for cooling the outside air ,type of coolers and the source from where the cooling water has to be taken to cool the air may be specified by the supplier in technical bid.

25.38.1 Fresh Air Supply

The proposed ventilation of the power house complex shall cater to three (3) areas along with their approach/access/escape passage isolated from each others namely, machine hall, cavern including annex bays floors, transformer hall and GIS Hall cavern, main access tunnel.

Air changes for various rooms and different areas shall be as per relevant Indian or International standard.

25.38.1.1 When the indoor temperature is below 18^0 C the temperature controlled system will operate return air dampers of M/C hall and Transformer hall ventilation supply air rooms to the fully open position and a portion of the used air will be sucked by the supply fans which will get mixed with the cool fresh supply air entering into the power house.

25.38.1.2 When the power house indoor temperature is above18^0 C, the temperature controlled system will operate return air dampers of M/C hall and Transformer hall to the fully closed position. The hot air will be discharged outside the power house alongwith exhaust air of toilets, batteries etc. through exhaust fans.

Kindly refer Sub-scetion C1 of Technical Specification.

25.38.2 Ventilation system in the premises of Machine Hall cavern including Annexe Blocks (Supply System & Exhaust System)

25.38.2.1 The machine hall cavern with annexe blocks at either end shall be furnished air from two service and one standby ventilation plants for each of the systems located in the annexe blocks near S/Bay & Unit-4 bay respectively. Outside air will be taken from the ventilation tunnel /drainage gallery up to the ventilation plants of system. Air shall be supplied to each floor over air ducts to various locations in the M/C hall including annexe blocks and upto the drainage gallery. Air shall be fed into ventilation ducts which pass through various floors, and branch ducts are tapped from the vertical ventilation duct for distributing air to all premises of the machine hall cavern including annexe blocks. The total capacity of the ventilation plant of the systems has to be estimated by the contractor and approved by the THDC.

25.38.2.2 From all levels of the machine hall cavern, air shall come out through the gratings/openings to be provided for installation/removal of runner & through staircase etc. by the stack (chimney) effect. Some of the exhaust air will pass through the main access tunnel on its own to outside the power house. Hot air which is accumulated near the crown shall be sucked through return air grilles in the machine hall and shall be exhausted alongwith exhaust of some of the premises in Annexe blocks such as D.C. Battery room, DCDB room, toilets, domestic sewage tank pump rooms & lubricating oil plant room to out side the power house through exhaust fans of systems located in exhaust air blower rooms in the Annexe blocks near S/bay & unit-4 side. The rating of the exhaust fan has to be estimated by the contractor and approved by purchaser.

25.38.2.3 The exhaust ducts of fan systems shall be combined together & laid in the crown of the vantilation-cum emergency escape tunnel. The combined exhaust duct from fan systems of the transformer hall shall also join this duct at the junction point of ventilation tunnels, and the combined exhaust shall be delivered to a blower room having another set of exhaust air fans (1 working & 1 standby) system. This blower room is proposed in the service building near Main Access Tunnel and the capacity would be estimated by bidder & approved by purchaser.

25.38.3 Storage Battery Room in Annexe Block near S/Bay

25.38.3.1 The battery room shall receive fresh supply by induction i.e. by using exhaust fans to avoid pressurized room which would emanate acid fumes and hydrogen into the machine hall etc. The exhaust air from battery room area shall not get mixed with fresh air supply. The fresh air shall enter the battery room from louvers. The exhaust system shall have 100 % redundancy.

25.38.3.2 The ducts, fans etc. shall be acid proof.

25.38.3.3 Air removal quantities designed to reduce the hydrogen concentration to the permissible limit will be handled from the upper zone of the battery room with the aid of ventilation plant E-1 located in another Ventilation Chamber at El 531.5m in annexe block. Air will be discharged outside power house via an exhaust duct made of sheet metal located in the ventilation-cum- emergency escape tunnel which will be coated with acid resistant paint.

25.38.4 Amenity rooms (W.Cs. etc.) in Annexe blocks

Air from the amenity rooms (toilets) and the domestic sewerage disposal tank/pump station shall be exhausted with the

exhaust ventilation fans systems consisting of two ventilation units. Fresh air into the amenity room area shall be sucked through sashes/louvers provided in the bottom half portion of doors.

25.38.5 Vaults of Power Transformers (Supply Systems & Exhaust System) :

25.38.5.1 The transformer vaults are fire hazardous locations. Air shall be supplied to the transformer vaults by the air supply system comprising two service and one standby ventilation plants. The capacity of each ventilation system would be calculated by the contractor and approved by the purchaser.

25.38.5.2 Outside air shall be supplied by the ventilation tunnel leading to the ventilation chambers located in annexe blocks at either end of the transformer-cum-GIS hall.

25.38.5.3 Air shall be exhausted from the transformer vaults through the open fire doors of the transformer vaults as well as through exhaust ducts. In case of emergency (fire), the fire doors shall be shut automatically and smoke (after the fire is extinguished) shall be sucked through the air duct of exhaust system running near the ceiling of floor in the transformer vaults area with the aid of the exhaust plants located in the ventilation chambers in the two annexe bays of the transformer hall. Air shall be discharged outside through the exhaust ducts to be laid in the ventilation-cum-emergency escape tunnel. The supply and exhaust air ducts shall be equipped with fire dampers which shall close automatically, if fire breaks out in any of the transformer chambers. The above exhaust fans shall also discharge hot air entrapped in the crown of GIS hall for which requisite number of return air grilles shall be provided in the crown of the GIS hall.

25.38.6 Bus-Duct Galleries

Each of the four bus-duct galleries shall be supplied air from the GIS hall side by the above supply systems. Air at a temperature of about 34^0 C shall discharge into the machine hall & shall pass out of the power house through the Main Access Tunnel.

25.38.7 420 KV GIS Hall, Transformer Transfer Zone, Switchgear & other rooms in Annexe Blocks of Transformer Hall

Supply ventilation of the above locations shall be accomplished with the above ventilation systems. The air ducts shall supply air from the supply ventilation plants to the rooms in the

annexe blocks at either end of transformer hall, 420 kV GIS hall & transformer transfer zone. Air exhausted from the rooms of annexe blocks & GIS hall shall be let out through 400 kV cable tunnel to outside the power house in the pothead yard area. Some of the air shall also be exhausted through the access tunnel to the transformer hall.

25.38.8 **Transformer oil handling facility & amenity rooms in Transformer Hall area & Exhaust System**

The amenity rooms & transformer oil handling facility shall be provided with the same supply/exhaust system. Air shall be discharged outside through the exhaust duct laid in the ventilation tunnel to the approach road area. As the oil handling facility belongs to the fire hazardous location, supply & exhaust air ducts shall be equipped with fire dampers to be installed at the inlet to the room which shall close automatically in case of fire in the room. For amenity rooms, sashes are proposed at the bottom portion of doors from where fresh air supplied by the above system would enter. Only return air grilles in the exhaust duct are envisaged for amenity rooms.

25.38.9 Smoke free air pressure system

25.38.9.1 Provision shall be made to create positive air pressure (minimum 20 mm w.c.) during fire (with one of the doors being opened) in the smoke-free stair way and elevator hoist way with the aid of the ventilation systems. The capacity of ventilation fans and plant would be calculated by the contractor and approved by the purchaser.

25.38.9.2 These fans shall operate automatically at preset regular intervals as well as during emergency condition & the pressurised air in the stair case / lift shaft areas shall prevent entry of smoke, thus helping power house personnel to escape out from the underground power house to outside through the ventilation-cum-emergency escape tunnel.

25.38.10 Butterfly Valve chamber

Two Nos. fresh air supply fans are proposed at the portal of access tunnel to B.F.V chamber which shall carry fresh air through ventilation duct installed in the crown of access tunnel upto the BFV chamber. Exhaust air shall come out of the tunnel/construction adit on its own, thus ventilating these zones also.

25.38.11 Main Access Tunnel

The exhaust air coming out of the power house caverns through the main access tunnel on its own shall be sucked intermittently by a fan system through air grilles in the access tunnel so as to clear the tunnel from any smoke of the vehicle (entering the power house) expeditiously. At the time of emergency (i.e. fire in the power house) a set of motorized dampers installed at the inlet & outlet of fans shall get automatically closed and another set of dampers (installed in the branches to inlet & outlet of fans) shall open. The fans shall also start automatically and inject fresh air into tunnel, and near the junction points of access tunnel with the M/C hall & transformer hall, thereby producing a sort of air curtain, thus retarding the outflow of smoke from the power house cavern to the main access tunnel, so that power house personnel can come out safely.

The bidder shall study the above scheme proposed for supply &exhaust ventilation system particularly smoke free air pressure system and reversible flow fan system and may suggest alternative scheme for consideration of the purchaser. The final scheme as prepared by the bidder has to be approved by the purchaser.

25.39 DRAWINGS, DATA & MANUALS

Drawings, Data & Manuals shall be submitted in 7 copies of quantities and procedures as specified in General Condition of Contract and/or elsewhere in the specification.

To be submitted with the Bid:

a) General arrangement drawing showing constructional features, space required in front for withdrawals of breakers, power & control cable entry points for control panels, centrifugal blowers & motors etc.
b) Bill of Materials.
c) Typical breaker and ventilation system control schematic.
d) Type test reports on circuit breaker.
e) Technical leaflets on circuit breaker & other electrical equipment to be provided on MCC, centrifugal blowers & motors, filters, dampers, grilles etc.
f) Guaranteed and other technical particulars as per format in the specifications, schedule of supplies, spares, tools etc.

25.40 INFORMATION TO BE FURNISHED BY THE SUPPLIER AFTER AWARD OF THE CONTRACT.

The supplier shall furnish to the purchaser within 60 days after the award of the contract the following information and technical documents for approval.

a) Detailed drawings for general arrangement of installation of ventilation system in power house complex & B.F. valve chamber.
b) Design calculations for designing the ventilation system of the powerhouse complex and butterfly valve cavern.
c) Provision for safety features for the system.
d) Write ups, description, catalogues, and photographs of components and assembly of the system.
e) Information of materials, standards, shop tests, site tests, site assembly and erection procedure.
f) Complete O and M manuals (6 copies).
g) Performance characteristics of fans and motors
h) Characteristics of each type of grilles and diffusers.
i) Outline drawings of the principal pieces of equipment showing major dimensions.
j) Layout of ducts and grilles/diffusers.
k) Weights and foundation plan drawings for designing foundations on floor slabs.
l) Spare parts.
m) Complete schematic diagram framed in a glass frame with suitable colour scheme of the ventilation system for hanging in the control room of the powerhouse for understanding/reference of the operating personnel.
n) Data on materials of major items giving mechanical properties and chemical constituents.
o) A consolidated list of various relevant Indian or other standards to which items of the systems pertain.
p) Outline dimensional drawing of the switchgear and control panels showing general arrangement, space requirements and bus duct/cable entry points.
q) Cross-section with parts list.
r) Cable routing arrangement with details of cable racks, supports etc. from MCCs to various equipment.
s) Single line diagrams.
t) Control schematics.
u) Wiring diagrams.
v) Instruction manuals of switchgear & individual equipment

The manual shall clearly indicate the installation method, check-up and tests to be carried out before commissioning of the equipment.

The Bidder may note that drawings, data and manual listed herein are minimum requirements only. The Bidder shall ensure that other necessary write-ups, curves and information required to fully describe the equipment shall submitted with his bid / after award of contract.

The test readings as obtained during testing of the equipment shall be submitted to the inspecting officer for approval.

25.41 QUALITY ASSURANCE

25.41.1 The bidder shall submit and finalize manufacturing quality plans for all the major components and equipments. These quality plans shall detail out various tests/inspections to be carried out as per the requirement of Technical Specifications and relevant Standards and quality practices and procedures followed by bidder's quality control organization. Manufacturing quality plan shall be approved by THDC.

25.41.2 All bought out items shall be of reputed make and conforming to standards:

25.41.3 No materials shall be dispatched from manufacturer's works before the same is accepted subsequent to pre-dispatch / final inspection including verification of records of all previous tests by THDC representative.

25.41.4 The bidder shall also submit field quality plan for site activities since receipt of material at site for THDC approval.

25.42 INSPECTION & TESTING

25.42.1 Inspection & Testing at Manufacturer's Works

All equipments covered under this specifications shall be tested in the presence of the purchaser or his authorised representative as per relevant Indian standards at manufacturer's works and test certificates in triplicates shall be furnished to prove that the equipment supplied meets the requirements of relevant IS specifications.

The following tests shall be carried out for air duct work.

i.) Verification of material test certificate.

ii.) The ducts, branches, elbows, tee points etc. shall be inspected and the joints and connections shall be checked before they are assembled in position.

iii.) After assembly, the system shall be checked for tightness, vibration and noise due to turbulence.

a) MCC and control panels shall be subjected to following tests:

- Temperature rise test on power circuits.
- Short time current tests on power circuits.
- Mechanical operation test.
- High voltage test.
- Electrical control, interlock and sequential operation tests.
- Verification of wiring as per approved schematic.
- Type tests and routine tests shall be carried out on all associated equipment as per relevant standards.

Bidder shall be responsible for conducting tests as per IS, before termination of the cables, i.e. measuring insulation resistance of each core to earth and core to core, identification of cores, all tests before and after termination etc.
Certified copy of all routine/type tests certificate shall be submitted for approval before despatch of equipment.

All fans, blowers, motors and other equipment shall be checked for correct alignment, lubrication of bearings and direction of rotation.

Entire system shall be tested under operating conditions for performance and leakage after completion of work. The rate of air flow shall be measured at each grille and shall be within ± 5% of the specified quantity. The air quantities shall be measured in accordance with methods set out as per relevant IS.

Equipment that fails to test requirements shall be corrected and tested again until satisfactory results are obtained.

All facilities, instruments, equipments and man power required to carry out the tests shall be arranged by the bidder.

25.42.2 Tests at Site:

After completion of erection at site, tests to be performed shall include but not limited to the following:

i.) Measurement of Insulation Resistance of Bus bars and Power circuits

ii.) Testing and checking of Control Scheme/Annunciation Scheme.
iii.) Operation test of MCCB (local/remote)
iv.) Testing of Auto-changeover Scheme of incoming breakers

Bidder shall be fully responsible for correct terminations, and if at the time of commissioning some modifications/rectifications are required the same shall also be carried out by him free of cost. If any terminations/cable boxes etc. fail at the time of commissioning, bidder shall be responsible to replace the same free of cost.

25.43 FINAL ACCEPTANCE TESTS

25.43.1 After site testing has been satisfactorily completed, the final acceptance tests scheduled below shall be conducted under the supervision of supplier and purchaser to ascertain that all manufacturing guarantees and requirements of the specifications have been met as below:

i.) Ventilation systems (including electrical equipments) shall be operative continuously for 30 days after commissioning and prior to handing over to the owner. During this period there shall be no imbalance, vibration & noise in the system.

ii.) All tests as per relevant standards/technical specification shall be a part of the final acceptance tests.

iii.) A record of all performance tests shall be embodied in test report.

iv.) Successful completion of the final acceptance tests shall be a condition precedent to a final acceptance certificate in respect of Ventilation system (including electrical equipment).

25.43.2 Erection & Commissioning

The Supplier shall provide requisite numbers of engineers and other personnel for erection, testing, and commissioning at site. The supplier shall ensure that the complete set of equipment as well as the individual components function in accordance with the requirements and guaranteed technical particulars outlined in the specifications. After commissioning, a performance test report shall be jointly prepared by engineers of supplier and purchaser.

25.43.3 Taking Over

The entire system shall be taken over by the purchaser only after the system complies the operational requirements of the specifications and remains in trouble free operation continuously for 30 days.

25.44 SPARE PARTS

25.44.1 Following spares for 5 years of operation shall be supplied:

a) Bearings set for each type of fan;
b) Bearings set for each type of electric motor;
c) V-belts / flexible coupling set for each type of fan.
d) Filter element- 2 sets.
e) Water cooler – 1 set

25.44.2 Further for assembly and operation of equipment special devices, lifting mechanisms, testing devices, etc. which is necessary shall be supplied by bidder. The list of such items alongwith price shall be indicated separately.

25.44.3 The bidder shall submit with his proposal recommended list of spare parts other than above required for the first five years of satisfactory operations. Full details of all spare parts with their relation to the equipment and item-wise prices shall be furnished.

25.45 MAKES OF EQUIPMENTS

The equipment used for ventilation system shall be of reputed make preferably as detailed below or equivalent:

1.	Fan	Flakt Woods/ Kruger / Andrew Yule/ Aerotherm/ Duvent / Siwent (Sarla)/ S. R. Paryavaran/ GEC (Alstom)
2.	Motors	ABB/Siemen/Crompton Greaves/ Kirloskar / G.E.C.
3.	Filters	Anfilco/Chemfarm/Kirloskar / Clear Air Purofil/Airtect/Dyna
4.	Switchgear	(MCCB,Crompton/Siemens/ABB/L&T Contactors etc.)
5.	Grills/Diffusers	Moosa Haji/Nutech/Cosmos/Opella/ Caryaire

6.	Galvanised sheet steel	SAIL/Nippon / TATA
7.	Pressure Gauge and Thermostats	H. Guru/Fiebig/Japsin/Mica
8.	Resin bonded Fibre glass	UP Twiga/Clyol/Cooline/
9.	Thermostats	PENN/Honeywell
10.	Cables	Finolex/NICCO/Universal Cables / Grandley / CCI / Polycab / Fort Gloster

The names of venders other than the one listed above shall be subject to the approval of the purchaser. The information and experience of the proposed sub-vendors shall be furnished by the bidder.

25.46 COMPLETENESS OF EQUIPMENT

The bidder shall supply complete equipment of the package in all respects and include all fittings and accessories which may not be specifically mentioned in this specification but which are essential for the completeness and successful commissioning of the equipment offered.

The bidder shall ensure testing and commissioning of the complete ventilation equipment including start-up equipment, sensors, control cabinets, power and control cables in conformity with specifications.

The bidder shall prepare and submit all control schemes and drawings of cable connections.

25.47 QUALITY CONTROL & ASSURANCE

The supplier has to supply the equipment for Ventilation equipments of best quality. The Supplier has to maintain quality control and assurance during the manufacturing of equipment as per approved owner's quality assurance plans.

ANNEXURE-I

SCHEDULE OF REQUIREMENTS

S. No.	Description	Qty.
A)	**Supply & Exhaust Air Fans**	
	Supply / Exhaust air fans of suitable rating complete in all respects with motors, base frame, switchgear etc.	
I.	Supply fan system (capacity in m^3/hr. & pressure rating in mmwc would be given for each system along with no. of fans.)	As required
II.	Exhaust fan system (capacity in m^3/hr. & pressure rating in mmwc would be given for each system along with no. of fans.)	As required
B)	**Other Equipments**	
1	Air control devices such as a) Fire dampers b) Check valves (back draft dampers) c) Volume control dampers d) Split dampers	As required
2	Air filters & Air washers to be installed at	
	Ventilation room in M/c Hall annexe in SCA	As required
	Ventilation room in M/c hall annexe at far end	As required
	Ventilation room in Tr / hall near adit end	As required
	Ventilation room in Tr/ hall annexe at far end	As required
	B.F. Valve Chamber (Blower room)	As required
3	Vibration isolators for fans & motors sets	As required
4	Flexible inserts (Canvas connectors)	As required
5	Special tools required for erection , operation & maintenance of the equipment	1 Lot
6	Supply grills / ceiling diffusers	As required
7	Return air grills	As required
8	Galvanized sheet steel duct of following gauges and thickness :	

S. No.	Description		Qty.
	Gauge - 20	1 mm	As required
	Gauge – 22	0.8 mm	As required
	Gauge - 24	0.6 mm	As required
9	Galvanised steel support structures complete with embedments in concrete wall, rock foundation, hardware etc. as required for the ducts of Ventilation system.		1 Lot
10	ERW pipe (light grade) of 100 mm N.D. as per IS : 1239 (Part I)		As required
11	Temperature sensors & indicators for local & remote position indication		As required
12	Humidity sensors & indicators for local & remote position indication		As required
13	Dilatometric thermostatic switch/controller		1 No.
14	Fire resistant insulation material / board for ventilation ducts as per specification		As required
15	Acoustic lining material for fans & ducts as per specification		As required
16	Suitable earthing material complete with earthing terminals, bi-metal clamps, washers, lugs, pads, hardware etc. for complete system to be connected to the ground mat riser provided by purchaser in the vicinity of work		1 Lot
C	**Electrical Equipment**		
1	Motor Control Centers (MCC) for air supply and exhaust ventilation systems of Machine Hall and annexes.		As required
2	MCCs for air supply and exhaust ventilation systems of Transformer Hall		As required
3	MCC for air supply of main ventilation system for M/c hall & Transformer Hall caverns		As required
4	MCC for fresh air supply ventilation system for		As required

S. No.	Description	Qty.
	Butterfly Valve Chamber	
5	MCC s for air exhaust ventilation system from Tr. Hall and M/c hall	As required
6	MCC for reversible ventilation system of Main Access Tunnel of P. H.	As required
7	Central control and annunciation panel for ventilation system to be installed in Control Room	As required
8	Push-button station for local control of ventilation systems (as required for the equipment covered under the specification)	As required
9	Control boxes for local control of fire-dampers, as required for the equipment covered under the specification.	As required
10	Control boxes for power packs for sensors measuring temperature & humidity	As required
11	Terminal boxes & control modules for the equipment covered under the specification.	As required
12	Power and control cables with glands, lugs and their accessories, conduits, cable racks, cable support system, clamps, etc.	As required
13	Power cables of the below given grades.	
	1.1 kV grade, PVC insulated, PVC sheathed, unarmoured, 3 ½ core, solid copper conductor cables of various sizes	As required

ANNEXURE – II

SCHEDULE OF TECHNICAL PARTICULARS FOR VENTILATION SYSTEM EQUIPMENTS

Sl. No.	Description	Data
A)	**Ventilation Fans (separately indicate for each rating of fan i.e. for fresh air, supply and exhaust fans of each ventilation system to be furnished).**	
i)	Nos., Capacity & Pressure rating of the fan	
ii)	Speed of the fan	
iii)	Space required for each fan in the ventilation room where the fans are proposed to be located.	
iv)	Model number, make and impeller diameter of each fan.	
v)	Type and class of construction.	
vi)	Volumetric efficiency and noise level of each fan.	
vii)	Shaft horse power requirement of each fan.	
viii)	Overall size and weight of each fan.	
ix)	Whether performance curve of each fan enclosed (Yes/No).	
x)	Whether general arrangement/ foundation drawing of each fan system enclosed (Yes/No).	
xi)	Whether design calculations for each fan system supplied (Yes/No).	
xii)	Type of fan shaft bearings offered.	
xiii)	Type of drive with details.	
xiv)	Material of construction of important fan parts such as shaft, hub, blades, casing, bearings etc	
B)	**Induction Motors Insulation Class (separately for each type of fan to be furnished)**	
i)	Name of manufacturer of each motor.	
ii)	Duty/ Rating of motor.(Kw)	
iii)	Rated speed of motor (rpm).	
iv)	Full load efficiency of motor (%).	
v)	Whether dimensional drg. enclosed (Yes/Not).	
vi)	Type of protection adopted.	
vii)	Method of starting (DOL or Star/Delta Starter).	

Sl. No.	Description	Data
viii)	Current at (a) full load (b) starting (% of F.L.).	
ix)	Temp. rise over ambient temp. (^{0}C).	
x)	Voltage	
xi)	Insulation Class	
C)	**Filters (separately for each location to be furnished**	
i)	Model No., Make and type offered (washable/throwaway).	
ii)	O/A size and numbers of filters (L x W x H) provided at each location.	
iii)	Rating (M^3/Hr.) and efficiency.	
iv)	Pressure drop in clean and saturated (clogged) condition in (mm) of w.g.	
v)	Filter media.	
vi)	Normal period when cleaning is due and method of cleaning.	
vii)	Method of testing of filter.	
viii)	Weight of each panel.	
D)	**Metal Air Ducts.**	
i)	Manufacturer's name.	
ii)	Material of construction.	
iii)	Thickness of sheet adopted for max. dimensions.	
iv)	Type of construction.	
v)	Supporting frame details attached (Yes/No).	
vi)	Thickness of insulation for air conditioning ducts (mm).	
vii)	Thermal conductivity and density of material of insulation.	
viii)	Static pressure drop/unit length ((mm) wg).	
ix)	Maximum velocity of air in ducts.	
x)	Whether details of fixing ducts to walls/ceiling attached (Yes/No).	
xi)	Particulars of each duct section (Air flow, dimensions, gauge of sheet metal and location of duct).	
xii)	No. and type of bends/other fittings with friction drops.	
E)	**Dampers (Separate details for Volume Control Damper, Fire Damper and Back Draft Damper to be given).**	
i)	Manufacturer's name.	

Sl. No.	Description	Data
ii)	Type and material of construction.	
iii)	Type of control (manual/automatic).	
iv)	Overall dimensions and weight.	
v)	Friction drop.	
vi)	Capacity.	
F)	**Grills/Diffusers**	
i)	Name of manufacturer.	
ii)	Capacity (M^3/Hr).	
iii)	Terminal velocity (M/min).	
iv)	Outlet velocity (M/min).	
v)	Size of grills/diffusers provided at various locations.	
vi)	Material.	
vii)	Air throw and drop.	
viii)	Whether volume control damper provided behind grille / diffuser (Yes/No).	
ix)	Friction drop in grill/register.	
x)	Total number of grills/registers with sizes for each fan system provided.	
G)	**INSTRUMENTS**	
i)	Make, location and quantity of Pr. gauges provided.	
ii)	Make, location and quantity of Temp. gauges provided.	
iii)	Make, location and humidistats provided	
iv)	Instruments mounted on local panels (indicate full list)	

Place : **Signature of Bidder**

Date: **Stamp**

ANNEXURE – III

SCHEDULE OF TECHNICAL PARTICULARS FOR ELECTRICAL EQUIPMENT AND CABLES

Sl. No.	Description	Data
1.0	**MCC ASSEMBLY**	
	Make	
	Type	
	Reference Standard	
	Voltage (Nom./Max.) Volt	
	Phase, Frequency No., Hz	
	Short Circuit Rating	
	a) Interrupting kA Symmetrical	
	b) Short time for 1 sec. (kA rms)	
	Insulation Level	
	1-min, power withstand voltage (kV rms)	
	Construction	
	a) Metal clad, air insulated, floor mounting (Yes/No)	
	b) Suitable for mounting against building wall (Yes/No)	
	Enclosure	
	a) Degree of Protection	
	b) Minimum thickness of sheet metal (mm)	
	MCC fully assembled, wired and tested at factory (Yes/No)	
1.1	**CONSTRUCTION**	
	Design	
	a) Complete compartmentalised	
	b) Working height limits from floor level (mm)	
	Control Compartment	
	Whether provided with individual front access door	
	Whether MCC section provided with	
	a) Removable back cover	
	b) Full height cable chamber	
	Horizontal wireway for inter panel wiring provided for each MCC	

Sl. No.	Description	Data
	All meters, relays, lamps etc. flush mounted type	
	Vertical Section Size	
	a) MCC (L x D x H) (mm)	
1.2	**BUSBAR**	
	Make	
	Material & Grade	
	Reference Standard	
	Continuous current rating at site condition, 38°C ambient and within cubicle	
	a) Main busbar Amp	
	Vertical busbar (minimum) Amp	
	Conductor Section	
	a) Main Busbar $(mm)^2$	
	b) Vertical Busbar $(mm)^2$	
	Max. temp. rise over 38°C ambient °C	
	Short-time current for 1 second (kA rms)	
	Whether separate chamber/phase barrier/shrouding provided for	
	a) Main Busbar	
	b) Vertical Busbar	
	Bus Connections	
	a) Silver plated	
	b) Provided with anti-oxide grease	
	c) Bimetallic connectors between dissimilar metals	
	Busbar support spacing (mm)	
1.3	**CONTROL MODULE**	
	Control Modules:	
	Whether fully drawout (Yes/No)	
	Power/Control disconnector silver plated for good contacts (Yes/No)	
	Drawout Modules of same type & rating are physically & electrically interchangeable (Yes/No)	
	Module sizes (L x D x H)	
	a) Incoming with	
	630 A Switch (mm)	
	400 A Switch (mm)	
	200 A Switch (mm)	

Sl. No.	Description	Data
	b) Outgoing feeder with	
	100 A Switch (mm)	
	63 A Switch (mm)	
	16 A Switch (mm)	
	c) Starter units with	
	300 A Starter (mm)	
	160 A Starter (mm)	
	63 A Starter (mm)	
	32 A Starter (mm)	
	16 A Starter (mm)	
	16 A Starter reversing (mm)	
1.4	**CIRCUIT BREAKER**	
	Make	
	Type	
	Reference Standard	
	Rated Voltage (kV)	
	Rated Frequency (Hz)	
	No. of Poles (No.)	
	Rated Currents	
	a) Continuous (at site condition, 40°C, ambient & within cubicle) Amp	
	Short-time Current with 1 second (kA rms)	
	Max. temp. rise over 40°C ambient (°C)	
	Rated Operating Duty	
	Interrupting Capacity at rated voltage and operating duty	
	a) Symmetrical (kA rms)	
	b) Asymmetrical (kA rms)	
	Rated Making Current (kA peak)	
	Insulation Level	
	a) 1 min 50 Hz withstand (kV rms)	
	Operating Mechanism	
	a) Type	
	b) Trip free or fixed trip	
	Whether circuit Breaker provided with	
	a) Drawout feature having SERVICE, TEST & ISOLATED positions	
	b) Mechanical safety interlock	
	c) Manual operating handle	
	d) Emergency manual trip	
	f) Mechanical ON-OFF indications	

Sl. No.	Description	Data
	g) Overload release	
	h) Short-circuit release	
	i) Auxiliary switch with 6 NO and 6 NC contacts	
	Range of release	
	a) Overload	
	b) Short Circuit	
1.5	**CONTACTORS**	
	Make	
	Type	
	Reference standard	
	Duty class	
	Utilization category	
	Operating Coil Voltage	
	a) Rated	
	b) Pick-up	
	c) Drop-out	
	Continuous Current rating (A) 38°C & within cubicle	
	Power Consumption	
	a) During closing (VA)	
	b) After closing (VA)	
	Auxiliary Contacts furnished per Contactor	
	a) Normally open (NO)	
	b) Normally closed (NC)	
	Aux. Contact rating	
	a) Make & Continuous Amp	
	b) Break (Inductive) at:	
	240 V A.C. Amp	
	220 V D.C. Amp	
	Time range of delayed dropout contactors furnished Sec.	
	Thermal Overload Relay & Single Phase Preventor	
	a) Temperature compensated?	
	b) Hand Reset?	
	c) No & type of contacts	
	d) Thermal overload characteristics furnished	
	e) Tolerance on current injection	

Sl. No.	Description	Data
	1 – pole	
	2 – pole	
	3 – pole	
1.6	**PUSH-BUTTON LAMPS, METER, CT, TB etc.**	
1.6.1	Push Button	
	a) Make	
	b) Type	
	c) Cat. No.	
	d) Contact rating	
	Make & Continuous Amp	
	Break (inductive)	
	240 V A.C. Amp	
	220 V D.C. Amp	
1.6.2	Lamps	
	a) Make	
	b) Type	
	c) Cat No.	
	d) Watts/Voltage	
	e) Series resistor Ohm	
	f) Lamp & lens replaceable from front	
1.6.3	**METER**	
	Make	
	Type	
	Reference Standard	
	Size	
	Scale	
	Accuracy class	
1.6.4	**CURRENT TRANSFORMER**	
	Make	
	Type	
	Reference Standard	
	C.T. Ratings	
	a) Current ratio	
	b) Rated burden	
	c) Accuracy class	
1.6.5	**SECONDARY WIRING**	
	Type of Insulation	
	Voltage Grade	
	Conductor material	

Sl. No.	Description	Data
	Conductor size (minimum)	
	a) Potential Circuit $(mm)^2$	
	b) Current & Control Circuit $(mm)^2$	
	Whether wires identified at both ends with ferrules	
1.6.6	**TERMINAL BLOCK (TB)**	
	Make	
	Type	
	Cat. No	
	Voltage Grade	
	Whether 20% spare terminals furnished	
1.6.7	**BUS DUCT CONNECTION**	
	Details of Bus duct connection included as per drawing/bill of materials	
	Average length assumed for bus duct	
1.6.8	**CABLE TERMINATION**	
	Whether cable entry provision from top & bottom.	
	Cable termination & connection arrangement furnished as specified	
	Power Cable Lugs	
	a) Type	
	b) Material	
	Details of Power Cable Glands	
	a) Make	
	b) Type	
	c) Materials	
	d) With tapered washers	
	Removable Gland Plate	
	a) Material for multicore cable	
	b) Material for 1/C cable	
	c) Thickness of the plate	
1.6.9	**GROUND BUS**	
	Whether Ground bus furnished?	
	Material	
1.6.10	**NAME PLATE/LABLES**	
	Material	
	Thickness	
	Size	

Sl. No.	Description	Data
1.7	**SPACE HEATER**	
	a) Thermostat controlled	
	b) Wattage	
	c) Voltage	
	Provision made for motor heater supply	
	Cubicle/Motor heater provided with individual switch fuse units	
1.8	**TROPICAL PROTECTION**	
	a. Details of special treatment for tropical protection proposed to be provided if any	
	b. Whether screens are of corrosion resistant materials	
1.8.1	PAINTING	
	Finish of MCC/DB	
	a. Inside	
	b. Outside	
1.9	**SEISMIC PROTECTION Provided (Yes / No)**	
2.0	**LOCAL CONTROL CABINETS AND ANNUNCIATION PANELS**	
	Make	
	Type	
	Reference standard	
	Voltage (Nom/Max)	
	Cubicle Data	
	Size, dimensions	
	Rear door (Yes/No)	
	Metal clad, floor mounting (Yes/No)	
	Suitable for mounting against building wall (Yes/No)	
	Minimum thickness of sheet metal (mm)	
	Total mass (weight) with all relays and unit (Kg)	
	Degree of protection (not less IP54)	
	Ground bus:	
	Ground bus furnished	
	Material	
	Size	
	Cubicle heater:	
	Thermostat controlled	
	Wattage	
	Voltage	
	Lockout switch	
	Tropical protection	
	Any special treatment for tropical protection	

Sl. No.	Description	Data
3.0	**Cables** (for each type indicate separately for control & power cables)	
1	Cable type	
a)	Type and size of cable	
b)	Standard applicable	
c)	Voltage rating (kV)	
d)	Permissible variation in i) voltage ii) frequency iii) combined voltage and frequency	
e)	Suitable for earthed/unearthed system	
f)	Name of Manufacturer	
2	**Conductor and its hardness**	
a)	Material copper/aluminium (indicate grade)	
b)	Nominal cross section area, $(mm)^2$	
c)	Form of conductor (circular/shaped)	
d)	Minimum No. of strands	
e)	Nominal dia of strand each strand (mm)	
f)	Whether strands are tinned (Yes/No)	
3	**Insulation**	
a)	Material (Mention type)	
b)	Minimum average thickness (mm)	
c)	Average dielectric strength, kV/(mm)	
d)	Suitability with regard to moisture. Ozone, acid, oil and alkaline surroundings	
4	**Insulation screen**	
a)	Material of the semi-conducting screen	
b)	Thickness of the screen (mm)	
c)	Whether extruded under triple extrusion process	
d)	Whether cooper tape screening is applied	
e)	Thickness of the cooper tape, (mm)	
f)	For braided screen, material and dia of screen wire and min. percentage coverage	
5	**Outer sheath/overall covering**	
a)	Material (mention type, if any)	
b)	Minimum average thickness (mm)	
c)	Whether anti-termite treatment has been given in the outer sheath (Yes/No)	
6	**Electrical properties**	
a)	Maximum DC conductor resistance at 20°C per km (ohm/km)	
b)	Maximum permissible conductor temperature (°C)	
	i) Under continuous full load	

Sl. No.	Description	Data
	ii) Under transient over loading conditions	
c)	Suitability with regard to moisture Ozone, acid ,oil and alkaline surroundings	
7	**Current ratings:**	
a)	In air (continuous) Amp.	
b)	In duct (continuous) Amp.	
c)	Reference ambient temperature for the above	
8	**Mechanical data:**	
a)	Overall dia of the cable (mm)	
b)	Weight of cable (mm)	
4.0	**Junction boxes**	
	Dimensions	
	Make	
	Whether perforated	
	Thickness of sheet	
	Material	
	Standards applicable	
	Suitability with regard to moisture Ozone, acid, oil and alkaline surroundings	

Place : **Signature of Bidder**

Date: **Stamp**

ANNEXURE – IV

SCHEDULE OF MANDATORY SPARES FOR 5 YEARS PERIOD

S.No.	Description	Make	Qty.

Place : **Signature of Bidder**

Date: **Stamp**

ANNEXURE-V

SCHEDULE OF DEVIATIONS FROM SPECIFICATIONS

Sl.No.	Specification Clause No.	Deviation from specification	Justification for deviation

Place : **Signature of Bidder**

Date: **Stamp**

SECTION – 26

AIR CONDITIONING SYSTEM

26.1 Scope

This specification is intended to cover the design, manufacture, transportation to site, freight, insurance, loading, unloading, storage, handling at site, erection, testing, commissioning and handover of Air Conditioning System (AC) with control and accessories for Vishnugad Pipalkoti Hydro-electric Project.

26.2 General Information

The Air Conditioning System is to be provided at the following locations.

i) Control room floor at EL 1046 m
ii) Conference room at EL 1042 m
iii) PLCC room at EL 1046 m
iv) GIS Protection Panel room at EL 1048 m
v) Elect. Lab. at EL 1038 m
vi) Shift engineer room at EL 1044 m
vii) Communication room at EL 1038 m

All rooms mentioned above are part of Power House building. In case of fire in any room of the conditioned space the supply and return air to the conditioned space shall be stopped.

For complete scope of work kindly refer Sub-scetion C1 of Technical Specification.

26.3 Data for Design / Plant Capacity

The data for design of the system are given at Clause 13.9 attached with the specification. Based on the design data conditions the Air Conditioning Load for the areas to be air conditioned is worked out and given out in Schedule of requirements. The Bidder shall carry out his own calculations and satisfy him regarding the refrigerating capacity required for maintaining the specified conditions inside the room before submitting the offers. If plant of higher capacity is required he shall clearly point out in his bid with justification thereof.

26.4 Description of Air Conditioning System

Suitable capacity and quantity of air conditioners shall be provided for the rooms mentioned in clause 26.2 to maintain the temperature and humidity level as indicated in clause 26.9. The evaporating units shall be suspended from the ceiling of the rooms over the false ceiling. The return air shall be collected through return air slits in the false ceiling and taken back to plenum formed above false ceiling. Fresh air for each room, if required, shall be supplied from the ventilation system provided for the power house. In case of fire

in any room of the conditioned space the supply and the return air to the conditioned space shall be stopped.

The system shall be complete with all requisite controls drain pipes, refrigerating pipes. The system shall be capable of maintaining desired room temperature adjustable by thermostatic and temperature control provided on the remote unit

26.4.1 Scope of Supply/Services

The scope of supply/services under this specification shall cover but not limited to the following equipments.

Mechanical Works

Split air conditioning units of each complete with all accessories, auxiliaries, including first charge of refrigerant and lubricating oil etc.

Ducting complete with duct hangers, supports and accessories etc

One (1) no. fresh air fan unit complete with ducting grill etc.

Drain water piping, fittings etc.

Electrical & Control & Instrumentation Works

One no. 415 V, 3 Phase, 4 wire distribution board

Necessary control units complete with equipment/devices required.

Maintenance of the above equipments for 3 years

Civil Works:

~~False ceiling with openings for diffusers,~~ Venetian blinds of light colour, under deck insulation of roof slabs and beams of control room floor & openings in walls, floor, roof and foundation as required shall be done by contractor. The contractor has to close and seal off opening in walls, roof etc. as required.

26.4.2 Equipment Specification

Evaporator unit shall be horizontally/vertically mounted type as required and constructed of galvanised steel sheet of thickness not less than 18 gauge. It shall be suitable for indoor installation above false ceiling and shall have provision for draining out condensate water.

Fan Section

The fan shall be centrifugal, statically and dynamically balanced and shall be made of heavy gauge aluminium. It shall be designed for low noise operation and capable of delivering required air against static head of ducting.

Cooling Coil Section

The cooling coil section shall consist of copper tubes with aluminium fins to provide efficient heat transfer between tubes and fins. Cooling coil section shall be suitably insulated. It shall be fed with liquid refrigerant through thermostatic expansion valve.

Filter Section

Synthetic washable air filter shall be provided for the blower suction. Coil filters shall not be acceptable.

Drain Pan Section

Galvanised steel drain pan having arrangement for faster disposal of condensed moisture from cooling coil section shall be provided. It shall be suitably insulated.

Condensing Unit

The condensate units shall be supplied in weather proof heavy gauge enclosure suitable for outdoor installation. Each unit shall comprise of 2 or 3 independent hermetically/ semi-hermetically sealed compressor units together with associated air cooled condensers, refrigerant tubing and electrical system so that if one compressor unit is down, the other compressors can remain in service. The condenser tubes shall be of copper having extended aluminium fins. The refrigerant shall be environment friendly. The condenser heat is removed with the help of a quiet, low speed propeller fan(s).

Duct Work, Diffusers and Accessories

The metal air ducts, if required, shall be made of galvanised steel. Rectangular ducts shall be provided. All duct runs shall generally be designed to have minimum frictional resistance, noise and vibration. The ducts shall be perfectly air tight. Ducts shall be designed, fabricated and installed as per IS: 655.

The ducts shall be supported by mild steel rods and mild steel angles. Mild steel rods shall be hung from building slab. All supporting material required shall be provided by bidder. Adjustable split dampers shall be placed at all suitable points for proportional volume control of the system.

The supply air ducting upto a distance of 3 meters beyond the fan discharge shall be acoustically lined from inside with 12 mm thick resin bonded mineral wool conforming to IS: 8183 finished with wire mesh.

The duct shall be insulated with 25 mm thick resin bonded mineral wool conforming to IS: 8183 and covered with insulation wrapped with wire mesh etc. Diffusers shall be made of heavy gauge extruded aluminium metal. These shall be provided with volume control damper, frame work and gasketing at each duct flange. The bidder shall furnish the layout plan of ducting and diffusers. The location of diffusers shall be finalised in coordination with lighting and fire fighting contractors who shall be working above false ceiling of these rooms.

26.4.3 Drain Piping

Necessary Galvanised Iron drain piping shall be provided and connected to the nearest drain.

26.4.4 Fresh Air Fan Unit

Fresh air fan unit shall be complete with the following:

a. Tube axial fan/centrifugal fan complete with drive motor.
b. Guard Screen wall cowl & bird screen.
c. Cleanable metallic viscous filter.
d. High efficiency dry fabric filter.
e. Dampers to adjust the fresh air quantity.

26.5 Electrical Work

The Air Conditioning units shall be complete with electrical starters, motor, wiring and protection. The electrical system shall be capable of operating on 415 V, 3 phase, 4 wire, 50 Hz system.

The bidder shall provide 415 V, 3 phase, 4 wire two no. feeders from 415V AC system for meeting the total power requirement of Air Conditioning System. The bidder shall provide one no. 415 V, 3 phase, 4 wire distribution board for distributing power supply to each Air Conditioning unit. Supply, laying and termination of incomer cable to contractor's distribution board as also supply, laying & termination of outgoing cables emanating from the distribution board to each Air Conditioning unit shall be carried out by the contractor. Further electrical wiring shall also be in the scope of Contractor.

The distribution board to be supplied and erected by the contractor shall be of 2.0 mm thick metal pedestal/ wall mounted dust tight modular construction.

The distribution board shall be installed in the corridor adjoining to control room.

Each compressor unit shall be provided with short circuit over load and under voltage protection.

26.6 Controls

Each Air Conditioning unit shall be controlled from a control box. The control box shall be of flawless metallic construction finished with white powder coated enamel paint.

The controls shall incorporate:

- Sequential start of compressor motors
- Overload and under voltage tripping
- ON/OFF indication of compressor and blower motors
- Temperature control switch to adjust the thermostat.

The control unit shall be fixed on the wall. Wiring between the control box, condensing and evaporator units shall be in the contractor's scope and it shall be done aesthetically.

In addition to fixed type control panel, a mobile remote control unit shall be provided for each air conditioning unit.

26.7 Erection, Testing and Commissioning

The receipt, storage and handling of materials at site are in the scope of contractor. Temporary space for storage at Site shall be provided by the contractor. Minor civil works for the purpose of erection of the package units shall be in the scope of the Contractor. After making requisite wall openings, chipping works etc. required for erection, the bidder shall restore the plaster/cover the holes to restore the finish of employer's civil works. The testing and commissioning of the units shall be carried out in professional manner by the Contractor's technical team which shall be fully equipped with necessary tools and measurement equipments required for testing and commissioning. All consumables including refrigerant required for commissioning shall be in the scope of Contractor.

26.8 Taking Over

The equipment will be taken over by the Employer after the Contractor has satisfactorily demonstrated the performance of complete equipment.

After completing the erection works and carrying out testing and commissioning, the Contractor shall offer the system to the Employer engineers for acceptance. The Employer shall observe the performance of the equipment by operating the package units for 30 days continuously in the summer season prior to taking over.

26.9 Spare Parts

The bidder shall submit with his proposal recommended list of spare parts required for the first five years of satisfactory operations. Full details of all spare parts with their relation to the equipment and item-wise prices shall be furnished.

26.10 Air Conditioning Load – Design Data

Additionally refer Sub-scetion C1 of Technical Specification.

			Summer	Monsoon	Winter
1.	Outside conditions	Max. D.B $_{O}$C	31	30	20
		Min. D.B $_{O}$C	22	20	0
	Maximum Relative Humidity			95%	
2.	Inside design conditions 22-24	D.B $_{O}$C	22-24	22-24	
	Relative humidity			50 % ± 5%	
3.	Areas to be Air Conditioned		Control Room, Conference room, PLCC Room, GIS Protection panel room, Elect. Lab & Shift engineer room, Communication room		

4. Floor Area (Relative humidity for all the below mentioned areas should be in the range of 50 % ± 5% for comfortable environment)

   a) Control Room :
   b) Conference room:
   c) PLCC room :
   d) GIS protection panel room
   e) Elect. Workshop
   f) Shift Engineer room
   g) Communication room

5 Roof Area in exposed shall be taken for design if any.

6 False Ceiling Pre-coated Aluminium.

7	False Ceiling height from indicated finished floor level	3.0 m unless specifically
8.	Duration of Plant operation	24 Hours / Day, continuously
9.	Fresh Air	As per relevant IS/International Standard
10.	Occupancy	10 persons
11.	Lighting Load	3000 W (Fluorescent)
12.	Equipment Load	2000 W

Both Lighting & Equipment load are indicative only. These shall be specified by EPC Contractor.

13.	Insulation	50mm thick resin blended mineral wool conforming to IS: 8183 on the underside of all air conditioning rooms.
14.	Venetian blinds	Underground Power station, Not applicable
15.	Wall construction	250 mm thick RCC end wall and 230mm thick brick side wall + 12 mm plaster inside +12 mm plaster outside.
16.	Roof construction	300mm thick finished Reinforced Cement Concrete slab
17.	Floor Construction	300mm thick finished Reinforced Cement Concrete slab.

26.11 QUALITY CONTROL & ASSURANCE

The supplier has to supply the equipment for Air conditioners of best quality. The Supplier has to maintain quality control and assurance during the manufacturing of equipment as per approved owner's quality assurance plans.

26.12 Schedule of Requirements

		UNIT	QTY	LOCATION
i)	Suitable capacity of Air conditioning units to maintain the parameters as indicated in clause no 13.9 , complete with all accessories, auxiliaries, first charge of refrigerant, lubricating oil and drain water piping etc. For the following rooms. a) Control Room : b) Conference room: c) PLCC room : d) GIS protection panel room e) Elect. Workshop f) Shift Engineer room g) Communication			
ii)	415 V/240 V; 3 phase/ single phase A.C. distribution board with MCCB controlled incoming & outgoing feeders.			
iii)	Wall mounted power supply control cubicle for each air conditioning unit			
(iv)	Ducting complete with necessary longers, supports and accessories.			
(v)	Diffusers complete with volume control dampers and frame work.			
(vi)	Electrical and C&I equipments.			

Annexure-I

Guaranteed & general technical particulars

1.	Split Air Conditioner			
a)	Make	-	_____	_____
b)	Nominal capacity	K Cal/hr.	_____	_____
c)	Capacity at given ambient conditions	K Cal/hr.	_____	_____
d)	Material and thickness of refrigerating piping	-	_____	_____
e)	3 phase, 415V 4 wire power required	KW	_____	_____
f)	Whether technical literature attached	Yes/No	_____	_____
1.1	Condensing (outdoor) unit			
i)	General	-	_____	_____
a)	Overall dimensions LxBxH	mmxm mxmm	_____	_____
b)	Weight	Kg.	_____	_____
c)	3 phase, 415V wire power required	KW	_____	_____
ii)	Compressor			
a)	Make of compressor		_____	_____
b)	Model		_____	_____
c)	Type of compressors		_____	_____
d)	Number of each compressors	TR	_____	_____
e)	Compressor motor rating	KW	_____	_____
iii)	Condenser			
a)	Quality		_____	_____
b)	Face (area)		_____	_____
c)	No. of rows	m^2	_____	_____
d)	Fins / CM.		_____	_____
e)	Tube material		_____	_____
f)	Fin material		_____	_____
g)	No. and type of fans		_____	_____
h)	Impeller diameter	mm	_____	_____
i)	Speed	RPM	_____	_____
j)	Total air quantity	m^3/hr	_____	_____
k)	Fan motor rating	(whether 1 ph./3 ph.	_____	_____
1.2	Evaporator unit			
i)	General	-	_____	_____
a)	Overall dimensions LxBxH	mmxm mxmm	_____	_____
b)	Weight	Kg.	_____	_____

ii)	Evaporator Fan			
a)	No. and type of fans	-	_____	_____
b)	Impeller diameter	mm	_____	_____
c)	Speed	RPM	_____	_____
d)	Total air quantity	m^3/hr.	_____	_____
e)	Fan motor rating	KW	_____	_____
iii)	Evaporator coil			
a)	Face area	-	_____	_____
b)	No. of rows	-	_____	_____
c)	Fins / CM	-	_____	_____
d)	Tube material	-	_____	_____
e)	Fin material	-	_____	_____
iv)	Filter			
a)	Type	-	_____	_____
b)	Size and thickness of each filter	-	_____	_____
c)	No. of filters	-	_____	_____
2.	Drain Piping			
a)	Material	-	_____	_____
b)	Size-m	mm	_____	_____
c)	Total length included (including fittings)	M	_____	_____
3.	Fresh Air Fan Unit			
i)	Fan			
a)	Make	-	_____	_____
b)	Model	-	_____	_____
c)	Impeller diameter	mm	_____	_____
d)	Speed	RPM	_____	_____
e)	Capacity	m^3/hr.	_____	_____
ii)	Motor			
a)	Make	-	_____	_____
b)	Motor rating	-	_____	_____
c)	Type of enclosure	KW	_____	_____
d)	Class of insulation	-	_____	_____
iii)	Filter			
a)	Number of cleanable metallic viscous filters provided.	-	_____	_____
b)	Size of each filter provided.	-	_____	_____
c)	Number of dry fabric filter provided.	-	_____	_____
d)	Size of each fabric filter provided.	-	_____	_____
4.	Ducts, diffusers and accessories			
i)	Ducting			
a)	Material	-	_____	_____
b)	Whether all the accessories as specified shall be provided. If No. indicate deviations	Yes/No	_____	_____
ii)	Thermal insulation			
a)	Material	-	_____	_____
b)	Thickness	-	_____	_____
c)	Mode	-	_____	_____

d)	Make	-	_____	_____
iii)	Acoustic lining			
a)	Material	-	_____	_____
b)	Thickness	-	_____	_____
c)	Mode	-	_____	_____
d)	Make	-	_____	_____
iv)	Diffusers			
a)	Material	-	_____	_____
b)	Thickness	-	_____	_____
c)	Whether duct layout drawing attached	Yes/No	_____	_____
5.	Electrical			
5.1	Electrical protection provided for each motor.	Yes/No	_____	_____
5.2	Type and material of wiring in the scope of the bidder.	-	_____	_____
5.3	Details of material point on the condensing unit to which the purchaser's 3 P. 4 wire 415V feeder could be connected.	Yes/No	_____	_____
6.	Controls			
6.1	Write up on control system furnished	Yes/No	_____	_____
6.2	Protection provided for loss of refrigerant and over pressure due to condenser trouble.	Yes/No	_____	_____
6.3	List of LED's provided.	Yes/No	_____	_____
6.4	Size of control module.	Yes/No	_____	_____
6.5	Technical literature of control module attached.	Yes/No	_____	_____
6.6	List of local Instruments/Gauge to be provided.	Yes/No	_____	_____
6.7	Whether wiring diagram shall be furnished with the equipment.	Yes/No	_____	_____

Guaranteed Performance

We hereby declare that :

1. The Air Conditioning System shall maintain inside conditions as specified in the rooms.
2. Rating and performance figures of the equipment furnished by him are guaranteed.
3. Any defect/failure in our system shall be rectified/replaced by us free of cost up to the period of 12 months from the date of taking over at site.

Place :

Signature of Bidder

Date:

Stamp

ANNEXURE – II

SCHEDULE OF MANDATORY SPARES FOR 5 YEARS PERIOD

S.No.	Description	Make
	Qty.	

Place :

Signature of Bidder

Date:

Stamp

ANNEXURE-III

SCHEDULE OF DEVIATIONS FROM SPECIFICATIONS

Sl.No.	Specification Clause No.	Deviation from specification	Justification for deviation

Place : **Signature of Bidder**

Date: **Stamp**

SECTION: I

SUB-SECTION: C2-B

CUSTOMER SPECIFICATION

(PROJECT SPECIFIC GENERAL REQUIREMENTS)

SECTION-1

GENERAL TECHNICAL REQUIREMENT

1.0 GENERAL

1.1 This part covers technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in the bidding documents.

1.2 The scope covers to meet technical requirements for the design, engineering, manufacture, testing at manufacturer's works before dispatch, supply and services for insurance, transportation, delivery at project site, handling, storage and preservation at store/site, transport to the place of installation, complete work of site assembly, erection, testing at site and commissioning, assistance in operation & maintenance, handing over & remedial action, if any, upto defect liability period for electro-mechanical works as specified in various sections on EPC basis.

1.3 Any equipment, even though not covered in the specification in various sections but required for successful operation of the plant, shall be deemed to be covered in the scope of supply.

1.4 The contractor shall be responsible for complete engineering of the plant and prepare layout drawings of the underground power house, transformer cavern, GIS floor, cable tunnel, outdoor pothead yard, schematics, piping drawings, cable schedule, cable routing drawings, interconnection drawings etc. and submit the same for the approval of purchaser.

1.5 The parameters of the equipment specified are indicative only. The contractor shall prepare design memorandum containing the main parameters of all the equipment selected by him, Design Calculation, the safety factors adopted, the material used for fabrication of components in line with the latest design practice and the safety measures adopted against flooding and fire in the underground station. The contractor will submit this memorandum for purchaser’s approval.

1.6 The contractor shall carry out studies wherever considered necessary to determine optimum parameter of the equipment such as high voltage withstand levels, short circuit withstand levels, Short-Circuit Calculations**,** Insulation co-ordination Studies**,** Voltage Drop Calculations**,** Earthing Network Calculations**,** Generator Earthing System Calculation**,** Selection of LV Breakers and Minimum Cable Cross Sections and to ensure successful synchronisation of the plant with 400 kV system and its commercial operation.

1.7 The parameters and quantities of equipment, layout drawings and schematics indicated in the Technical Specifications are for guidance purpose only. The EPC contractor shall optimise the parameters, layout etc in line with modern practices and for trouble free operation of the plant.

1.8 The layout of 400KV switchyard shall be closely co-ordinated with the take off towers for 400 kV double circuit transmission lines.

2.0 DEVIATION & ALTERNATE PROPOSALS

2.1 The Bidders are not permitted to propose alternate technical proposals with their technical proposals. THDCIL will evaluate the technical aspects of the Bids to confirm that all technical specifications and requirements specified in the Bidding Documents have been met without any deviation, reservation or omission. Bids will be rejected in case of exceptions/deviations from the provisions, plans or specifications, material and services offered do not conform to the to the specifications and terms and conditions given in the Bidding document

3.0 COMPLETENESS OF FACILITIES

3.1 Bidders may note that this is a EPC turnkey contract. Each component of the plant shall be engineered and designed in accordance with the specification requirement. All engineering and associated services are required to ensure a completely engineered plant shall be provided.

3.2 All equipments furnished by the Contractor shall be complete in every respect, with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or those needed for erection, completion and safe operation of the equipment and for the safety of the operating personal, as required by applicable codes, though they may not have been specifically detailed in the respective specifications, unless included in the list of exclusions.

3.3 All similar standard components/ parts of similar standard equipment provided, shall be interchangeable with one another.

4.0 CODES & STANDARDS

4.1 In addition to the codes and standards specifically mentioned in the relevant technical specifications for the equipment / plant / system, all equipment parts, systems and works covered under this contract shall comply with all currently applicable statutory regulations and safety codes of the Republic of India.

4.2 Other International/ National standards such as DIN, VDI, BS, etc. shall also be accepted for only material codes and manufacturing standards, subject to the Employer's approval, for which the Bidder shall furnish, along with the offer, adequate information to justify that these standards are equivalent or superior to the standards mentioned above. In all such cases the Bidder shall furnish the complete word to word translation of the standard that is normally not published in English.

4.3 As regards highly standardised equipments such as Hydro Turbine and Generator, National /International standards such as JIS, DIN, VDI, ISO, SEL, SEW, VDE, IEC & VGB shall also be considered as far as applicable for Design, Manufacturing and

Testing of the respective equipment. In addition, these standards shall be referred for the design of machine foundations, wherever specifically mentioned in the specifications. However, for those of the above equipment not covered by these National / International standards, established and proven standards of manufacturers shall also be considered.

4.4 In the event of any conflict between the codes and standards referred to in the above clauses and the requirement of this specification, the requirement of Technical Specification shall govern.

4.5 In case of any change in codes, standards & regulations between the date of bid opening and the date when vendors proceed with fabrication, the Employer shall have the option to incorporate the changed requirements or to retain the original standard. It shall be the responsibility of the Contractor to bring to the notice of the Employer such changes and advise Employer of the resulting effect.

4.6 Material Standards

ASTM (American Society for Testing Materials), AISI (American Iron and Steel Institute) DIN (German Industrial Standards) and BSI (British Standards) are approved standards for the supply of materials.

Material tests according to DIN 50049-3.1 C shall be provided for all important parts of the equipment such as: steel plates for parts under hydraulic pressure, all major castings (runner, shut-off valve, etc.), large forgings (turbine and generator shaft etc.), high stressed large bolts etc.

For less important parts, certificates according to DIN 50049-2.3 are acceptable.

Materials shall be new and of first-class quality, suitable for the purpose, free from defects and imperfections, and the classifications and grades in conformance with the latest issue of the respective ASTM, AISI, DIN or BS standard. Material to other standards may be used if approval by the Owner has been obtained. Material specifications, including grade or class data, shall be shown on the appropriate detail drawings submitted for review.

The Contractor shall indicate in the Technical Data Schedules, the materials and applicable standards for all major parts of the supply.

The materials shall be carefully selected for the intended purpose and due consideration of the site conditions and the tropical environment. Higher grade material shall be used where ordinary material is insufficient.

"Not withstanding reference made to various standards all equipment and works as per provisions and requirements of relevant and latest Indian Standards shall be acceptable".

4.7 Units of Measurements

The international SI-system of units shall be used for documents, calculations, correspondence, drawings, etc., relevant to the Tender and the subsequent Contract.

5.0 EQUIPMENT FUNCTIONAL GUARANTEE

5.1 The functional guarantees of the equipment under the scope of the Contract are given in the Technical Specifications. These guarantees shall supplement the general functional guarantee provisions covered under Defect liabilities given in General Conditions of Contract.

5.2 Liquidated damages for shortfall in meeting functional guarantee(s) during the performance and guarantee tests shall be assessed and recovered from the Contractor as specified elsewhere in this specification.

6.0 DESIGN FACILITIES

6.1 All the design procedures, systems and components proposed shall have already been adequately developed and shall have demonstrated good reliability under similar conditions elsewhere.

6.2 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic requirements are detailed out in various clauses of the Technical Specifications. The design of various components, assemblies and subassemblies shall be done so that it facilitates easy field assembly and dismantling. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical or close to the operating range of the unit.

7.0 DOCUMENTS, DATA AND DRAWINGS TO BE FURNISHED BY CONTRACTOR

7.1 Bidders may note that this is a EPC turnkey contract. Each of the project component and equipment shall be fully integrated, engineered and designed to perform in accordance with the technical specification. All engineering and technical services required to ensure a completely engineered plant shall be provided in respect of mechanical, electrical and power systems, control & instrumentation as per the scope defined in various

sections of the Technical-Specifications.

7.2 The Contractor shall furnish engineering data in accordance with the schedule of information as specified in Technical Data Schedules and Technical Specification.

7.3 The number of copies/prints/CD-ROMs/manuals to be furnished for various types of document is given in **Annexure-I** to Technical Data Schedules.

7.4 **Engineering Information Submission Schedule**

7.4.1 Prior to the award of Contract, a Detailed Engineering Information Submission Schedule shall be tied up with the Employer. For this, the bidder shall furnish a detailed list of engineering information along with the proposed submission schedule. This list would be a comprehensive one including all engineering data / drawings / information for all bought out items and manufactured items. The information shall be categorized into the following parts.

i) Information that shall be submitted for the approval to the Employer before proceeding further, and

ii) Information that would be submitted for Employer's information only.

7.4.2 The Engineering Information Schedule shall be updated month wise.

7.4.3 The schedule should allow adequate time for proper review and incorporation of changes/ modifications, if any, to meet the contract without affecting the equipment delivery schedule and overall project schedule. The timely submission of drawings and data is as important to manufacture and delivery of equipment and hardware and this shall be duly considered while determining the overall performance and progress. The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under specifications. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be construed by the Contractor, as limiting any of his responsibilities and liabilities for mistakes.

7.4.4 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Documents and the entire works covered under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Engineer in writing.

7.4.5 The documentation that shall be provided by the Contractor is indicated in the various sections of specification. This documentation shall include but not be limited to the following:

7.5 **Basic Engineering Documentation**

Prior to commencement of the detailed engineering work, the Contractor shall furnish a Project Definition Manual within 12 weeks from the date of the Notification of Award. This manual shall contain the following as a minimum:

i) System description of all the mechanical, electrical, control & instrumentation.

ii) Sizing criteria of all the systems, sub-systems/ equipments/ structures/ equipment foundations along with all calculations justifying and identifying the sizing and the design margins.

iii) Schemes and Process & Instrumentation diagrams for the various systems/ sub-system with functional write-ups.

iv) Operation Philosophy and the control philosophy of the Main Plant and other plants.

v) General Layout plan of the power station incorporating all facilities in Bidder's as well as those in the Employer's scope. This drawing shall also be furnished in the form of CD-ROMs to the Employer for engineering of areas not included in bidder's scope.

vi) Basic layouts and cross sections of the main plant building (various floor elevations) and other areas including interface-areas included in the scope of the bidder.

vii) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

viii) The successful bidder shall furnish within three (3) weeks from the date of Notification of Award, a list of contents of the Project Definition Manual (PDMs), which shall then be mutually discussed & finalised with the Employer.

7.6 **Detailed Engineering Documents**

7.6.1 The contractor shall submit to the purchaser the following drawings/documents after the award of contract expeditiously in a sequential manner. Drawings shall be submitted in AUTOCAD format and the documents shall be submitted in PDF format. The bidder shall indicate separately the time schedule for submission of drawings for all the equipment covered in different sections for the approval of Purchaser, keeping in view the overall commissioning schedule of the project**.**

i) General layout plan of the station.

ii) Layouts, general arrangements, elevations and cross-sections drawings for all the equipment and facilities of the project.

iii) Flow diagrams, Process & Instrumentation Diagrams

iv) Piping composite layout drawings.

v) Purchase specifications/ technical data sheets for all bought out and manufactured items.

vi) Detailed design calculations for components, system, equipments etc., wherever applicable including sizing calculations for all auxiliaries.

vii) Transient & hydraulic analysis of the project components and system wherever applicable.

viii) Comprehensive list of all terminal points which interface with Employer's facilities giving details of location, end connection details, forces, moments etc.

ix) Power supply single line diagram, block logics, control schematics, electrical schematics, etc.

x) Protection system diagrams and relay settings.

xi) Cables schedules and interconnection diagrams.

xii) Cable routing plan.

xiii) Instrument schedule, measuring point list, I/O list, Interconnection & wiring diagram, functional write-ups, installation drawings for field mounted instruments, logic diagrams, control schematics, wiring and tubing diagrams of panels and enclosures etc. Drawings for open loop and close loop controls (both hardware and software). Motor list and valve schedule including type of actuator etc.

xiv) Alarm and annunciation/ Sequence of Event (SOE) list and alarms & trip set points.

xv) Sequence and protection interlock schemes.

xvi) Type test reports, insulation co-ordination study report and power system stability study report.

xvii) Control system configuration diagrams and card circuit diagrams and maintenance details.

xviii) Detailed software manuals & source software listing.

xix) Detailed flow chart for digital control system.

xx) Mimic diagram layout.

xxi) Model study reports wherever applicable.

xxii) Functional & guarantee test procedures and test reports.

xxiii) Documentation in respect of Quality Assurance System as listed out elsewhere in this specification.

xxiv) For equipment foundation, separate composite general arrangement drawings for equipment foundation shall be furnished by the bidder including the location of pockets/bolts/inserts/embedments/pedestals and extent of grouting, point of application of loads etc.

xxv) Instruction Manual as per Clause No. 7.9.

7.6.2 The Contractor's while submitting the above documents/ drawings for approval/ reference as the case may be, shall mark on each copy of submission the reference letter along with the date vide which the submissions are made.

7.7 **Engineering Drawings**

7.7.1 All documents submitted by the Contractor for Employer's review shall be in electronic form (soft copies) along with the desired number of hard copies as per Annexure-I of the Technical Data Schedule. The soft copies to be supplied shall be either in CDs, DVD or through direct transfer via E-mail, etc. The drawings submitted for approval could be in the image form.

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

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

7.7.4 The drawings submitted by the Contractor (or their sub vendor's) shall bear Employer's drawing number in addition to contractor's (their sub-vendor's) own drawing number. Employer's drawing numbering system shall be made available to the successful bidder so as to enable him to assign Employer's drawing numbers to the drawings to be submitted by him during the course of execution of the Contract.

7.7.5 The Contractor shall also furnish a "Master Drawing List" which shall be a comprehensive list of all drawings / documents / calculations envisaged to be furnished by him during the detailed engineering to the Employer. Such list should clearly indicate the purpose of submission of these drawings i.e. "FOR APPROVAL" or "FOR INFORMATION ONLY".

7.7.6 Similarly, all the drawings / documents submitted by the Contractor during detailed engineering stage shall be stamped "FOR APPROVAL" or "FOR INFORMATION" prior to submission.

7.7.7 The furnishing of detailed engineering data and drawings by the Contractor shall be in accordance with the time schedule for the

project. The review of these documents / data / drawings by the Employer will cover only general conformance of the data / drawings / documents to the specifications and contract, interfaces with the equipments provided by others and external connections & dimensions which might affect plant layout. The review by the Employer should not be construed to be a thorough review of all dimensions, quantities and details of the equipments, materials, any devices or items indicated or the accuracy of the information submitted. The review and / or approval by the Employer shall not relieve the Contractor of any of his responsibilities and liabilities under this contract.

7.7.8 After the approval of the drawings, further work by the Contractor shall be in strict accordance with these approved drawings and no deviation shall be permitted without the written approval of the Employer. Also soft copies of Approved drawings shall be supplied by contractor either in DVDs or Hard drives.

7.7.9 All manufacturing, fabrication and execution of work in connection with the equipment / system, prior to the approval of the drawings, shall be at the Contractor's risk. The Contractor is expected not to make any changes in the design of the equipment / system, once they are approved by the Employer. However, if some changes are necessitated in the design of the equipments / system at a later date, the Contractor may do so, but such changes shall promptly be brought to the notice of the Employer indicating the reasons for the change and get the revised drawing approved again in strict conformance to the provisions of the Technical Specifications.

7.8 **As Built Drawings**

7.8.1 After final acceptance of individual equipment / system by the Employer, the Contractor will update all original drawings and documents for the equipment / system to "as built" conditions.

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

7.8.3 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the contract documents and the entire works covered

under these specification shall be performed in strict conformity with technical specifications unless otherwise expressly requested by the Engineer-in-charge in writing.

7.9 Instruction Manuals

7.9.1 The Contractor shall submit to the Employer, draft Instruction Manuals for all the equipments covered under the Contract. The Instruction manuals shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The manual shall be specifically compiled for this project and shall be submitted during detailed Design Stage. After finalisation and approval of the Employer the Instruction Manuals shall be submitted as indicated in **Annexure-I**. The Contract shall not be considered to be completed for purposes of taking over until the final Instructions manuals have been supplied to the Employer. The Instruction Manuals shall comprise of the following.

7.9.2 Erection Manuals

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

i) Erection strategy.

ii) Sequence of erection.

iii) Erection instructions.

iv) Critical checks and permissible deviation/tolerances.

v) List of tool, tackles, heavy equipments like cranes, dozers, etc.

vi) Bill of Materials

vii) Procedure for erection.

viii) Procedure for initial checking after erection.

ix) Procedure for testing and acceptance norms.

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

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

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

7.9.3 Operation & Maintenance Manuals

7.9.3.1 The operating and maintenance instructions together with drawings (other than shop drawings) of the equipment, as completed, shall be in sufficient detail to enable the Employer to operate, maintain, dismantle, reassemble and adjust all parts of

the equipment. They shall give a step by step procedure for all operations likely to be carried out during the life of the plant/equipment including, operation, maintenance, dismantling and repair. Each manual shall also include a complete set of drawings together with performance/rating curves of the equipment and test certificates wherever applicable. The contract shall not be considered to be completed for purposes for taking over until these manuals have been supplied to the Employer.

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

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

7.9.3.4 The manuals shall include the following

i) List of spare parts along with their drawing and catalogues and procedurefor ordering spares.

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

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

iv) Detailed specifications for all the consumables including lubricant oils, greases, chemicals etc. required for the complete plant.

v) On completion of erection, a complete list of bearings/equipment giving their location, and identification marks etc. shall also be furnished to the Employer.

7.10 Plant Handbook and Project Completion Report

7.10.1 Plant Handbook

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

i) Design and performance data.

ii) Process & Instrumentation diagrams.

iii) Single line diagrams.

iv) Sequence & Protection Interlock Schemes.

v) Alarm and trip values.

vi) Performance Curves.

vii) General layout plan and layout of main plant building and auxiliary buildings

viii) Important Do's & Don't's

The final plant handbook complete in all respects shall be submitted three (3) months before start-up and commissioning activities.

7.10.2 **Project Completion Report**

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

7.11 **Clearance of Employers' Drawings:**

7.11.1 During detailed Engineering contractor will check the interface of relevant structural general arrangement drawings, foundation drawings, RCC drawings and arechitectural plan/elevation drawings furnished by the Employer for various areas and forward his consolidated observations/comments within three (3) weeks from the date of forwarding the drawings by the Employer.

8.0 Monthly Engineering Progress Report

8.1 During the period of contract, the Contractor shall, before the tenth (10^{th}) day of each calendar month, submit monthly progress reports in a format acceptable to the Purchaser, detailing the progress of the work during the preceding month. The report shall contain but are not be limited to the following information:

i) A general description of the Works performed during the reporting period on each main activity and include any notable problems which were encountered.

ii) The total overall percentages of erection works completed, with reference to the CPM programme. Appropriate comments shall explain differences if any.

iii) The percentages of each main work activity completed during the reported month with reference versus the scheduled programme. Appropriate comments shall explain differences if any.

iv) A list of all activities of scheduled and actual progress during the reporting period including actual starting dates versus scheduled starting dates and actual completion dates versus scheduled completion dates for each activity. Appropriate remarks shall explain differences if any.

v) A list of activities scheduled to be started within the next period of two (2) months, with expected starting and completion dates. If the expected starting and / or completion dates are different from those shown on the CPM programme, an explanation shall be given.

vi) A list of local manpower (by trade classification) employed during the reporting period.

vii) A list of expatriate personnel (by position) employed during the reporting period.

viii) A list of the Contractor's Equipment and materials presently located at the Site. Also a list of equipment and materials, which arrived at the Port of arrival and is in the process of being cleared through customs.

ix) Progress photographs of significant events. The Purchaser may direct the inclusion of specific photographs if deemed necessary.

x) Main items of temporary facilities constructed during the reporting period.

xi) A statement detailing the status of progress on the overall programme and how to regain any lost time or set-backs which may have occurred.

xii) A list of inoperable temporary equipment, and the estimated date when the repair will be completed.

xiii) A statement concerning potential problems and recommendations on how they could be resolved.

xiv) A list of drawings/engineering information which remains unapproved for more than four (4) weeks after the date of first submission

xv) Drawings which were not submitted as per agreed schedule.

8.2 The draft format for this report shall be furnished to the Employer after award of the contract, which shall then be discussed and finalised with the Employer.

9.0 Programme of Work Schedule

9.1 According to the relevant articles in the 'Condition of Contract, the progress of the work shall conform to the basic Programme of Work Schedule on which the Contract is based.

9.2 The detailed programme / schedule of work shall be submitted in accordance with the Contract Conditions, and shall include the following information ;

i) Design work

ii) Procurement

iii) Shop work and testing

iv) Transportation to the Site

v) Loading & un-loading

vi) Intermediate storage

vii) Storage and handling at site

viii) Erection, testing and commissioning

ix) Trail run operation

x) Performance guarantees test

xi) Removal of erection equipment and clearing of Site

xii) Interdependence with work of other contractors.

9.3 The Contractor shall pay particular attention to the dates established for the submission of "installation and foundation" drawings with loading data, anchoring details, recesses, block-outs etc., and all information necessary for the preparation of the civil work design drawings.

9.4 Since the Schedule dates are dependent on the progress of other contracts, the Contractor shall suitably co-ordinate his operations at the Site with those of other contractors.

10 Painting and Surface Treatment

10.1 Scope

All the equipment furnished and installed by the Contractor shall be completely painted for final use, with the exception of those parts or surfaces that are expressly designated as unpainted. Surfaces to be painted shall receive the preparatory treatment and number of coats approved by the Owner. The Contractor shall perform all painting work in the shop, before shipment, followed by a field touch-up during or after installation. If accepted by the Owner, the Contractor may apply the last coat of paint at the site instead of applying it in the shop.

10.2 Standard Products

All materials, supplies, and articles furnished shall be the standard products of recognized reputable manufacturers, and shall be subject to Owner's review for acceptance.

10.3 Colour Schedule

	Colour	Standard Ref.
• Raw water pumps	Mint green	RAL 6029
• Raw water strainers	Mint green	RAL 6029
• Heat exchangers	Mint green	RAL 6029
• Turbines	Silicon gray	RAL 7032
• Governors	Silicon gray	RAL 7032
• Oil pressure piping	Yellow orange	RAL 2000
• Oil purification system		Yellow orange RAL 2000
• Lubrication oil piping	Yellow orange	RAL 2000
• Air compressors	Sky blue	RAL 5015

• Air piping	Light blue	RAL 5012
• Tops of generators	To be decided at a later date.	
• Transformers	- do -	
• Switchyard equipment	- do -	
• Enclosures for electrical power equipment	Melon yellow	RAL 1028
• Enclosures for electrical control and protection equipment	Pearl white	RAL 1013

11.0 Fluids and lubricants

11.1 General

The Contractor shall deliver to the Owner all equipment complete with initial fill of fluids, grease or lubricants, transformer oil, and replace any quantity used up or lost during installation and testing.

11.2 Compatibility

The oil used for the lubrication and oil pressure systems for the turbine, governor, and generator shall be ensured to be of the same type. In case of any deviation, approval of the owner shall have to be obtained by giving full justification as the above can not be allowed in normal case.

The Contractor shall coordinate with the owner, the type of fluids and lubricants used in the bearings.

Upon completion of the design, the Contractor shall furnish a tabulation confirming the quantities and types of fluids and lubricants required for initial application for each item of equipment.

11.3 Supply

The Contractor shall furnish the following:

- All oil for initial filling of all equipment supplied, plus 10% additional.
- Grease if required for initial filling of all of the equipment, plus 10% additional.
- Flushing fluids to flush and clean all systems.

11.4 Pipe Connections

External connections for all equipment shall be in accordance with the applicable standards.

Internal connections shall be in accordance with standards selected by the Contractor and accepted by the Owner.

Adequate pipe supports and mounting hardware shall be provided for all piping in the Contractor's supply.

11.5 Pressure Tests

Unless otherwise specifically accepted in the Contract Documents, equipment, vessels and tanks under internal pressure during service shall be subject to hydrostatic pressure testing. The test pressure shall be 1.5 times the maximum working pressure of the respective equipment, vessel or tank.

The test pressure shall be applied for a period of 8 hours without showing leaks or drop in pressure.

12.0 Dimensional Checks and Visual Inspection

Dimensional checks shall be performed on all major parts, components and partial assemblies, especially when close tolerances and fits are involved (tolerance of shafts, between stationary and moving parts, connecting dimensions for the assembly with other supplies, etc.). If the dimensional checks show discrepancies in measurement which may affect the fit, assembly or dismantling of the respective part or component, the same have to be corrected correspondingly. Such correction or modification shall, however, in no way lead to sacrifices with respect to reliability of operation or inter-changeability, and shall be performed only after the agreement of the Owner has been obtained. If the correction or modification cannot be carried out in accordance with the terms mentioned above, the part or component concerned may be subject to rejection. Faulty machine parts or equipment shall by no means be delivered.

All major finished surfaces shall be subject to visual inspection in the presence of the Owner. Runner blades, stay vanes and wicket gate feather profiles shall be checked by means of templates which should be prepared/manufactured exactly as per drawing, as far as possible.

13.0 Functional Tests

Functional tests on partial assemblies and/or complete assemblies shall be carried out as much as possible already in the manufacturer's workshops. Such tests shall be performed as far as possible under operation-like conditions.

When requested by the Owner, the functional tests shall be repeated until full proof has been obtained that the functioning of the assemblies will comply with the requirements of the Contract Documents.

14.0 Embedded Parts and Anchor Bolts

All embedded anchor bolts, rods, welding plates and support plates shall be provided. Anchor bolts shall consist of a threaded steel rod installed inside a pipe sleeve to provide lateral adjustment after the sleeve is embedded. The embedded end of the rod shall be provided with a steel plate which shall be welded to the rod and sleeve to provide anchorage and to prevent entry of concrete into the sleeve during installation. The threaded end of the rod shall be provided with two steel nuts and two steel washers to permit leveling and anchoring the equipment prior to grouting.

Approved types of expansion or chemical anchors shall be used where practicable for small equipment.

15.0 Electrical Equipment

15.1 General

The electrical equipment delivered under this contract shall be new and of high quality, suitable for the purpose it is intended for, free from defects and imperfections, and it shall be of the classifications listed herein, or their equivalents, subject to acceptance by the Owner.

The equipment shall meet the applicable IEC Recommendations, international standards such as ANSI - IEEE -DIN- SEN or others, that can be shown to be comparable to these. The IEC and IEEE recommendations for approval of equipment and tools are applicable.

The equipment design shall be suitable to render satisfactory operation under the conditions prevailing at the site, and the equipment shall operate satisfactorily under normal load and voltage variations. The design shall further include all necessary provisions ensuring the safety of the operating and maintenance personnel.

Each equipment assembly, or unit containing electrical devices and wiring, shall be completely wired in the shop. Wiring shall be neatly arranged and protected against mechanical damage, terminating in terminal blocks located in a connection box or cubicle, on or near the unit.

15.2 Auxiliary voltages

15.2.1 AC power

Three phase- system with grounded neutral for feeding three-phase and one phase consumers (connected between phase and neutral), type TN-C according to IEC Publication 364-3, 415/240 V □10%, 50 Hz □ 3%. Frequency variation under extreme condition may be □ 5%. All motors and other electrical apparatus should be designed to work continuously under □ 5% frequency variation and □ 10% voltage variation.

15.2.2 **DC power**

D.C. Systems, ungrounded, with earth fault detection

220V + 20% to -25% for the supply of main control circuits for high and medium voltage switchgear, protection circuits and to other larger essentials load.

48V + 20% to -25% for the supply to EPABX etc.

Other voltage systems eventually needed, shall be generated from the above systems by means of dc/dc converters, inverters etc.

15.3 **Temperature rises**

The temperature rise for the major electrical components is cited in the respective chapters of these Contract Documents. Whenever no special mention of temperature rise is made, it shall be understood that the temperature rise is in accordance with the IEC Recommendations.

15.4 **System Parameter**

Nominal	Variation under worst condition
Voltage 400KV	360-440KV
Frequency 50Hz	47.5-52.5Hz

16.0 **Electrical Equipment Enclosures**

16.1 **General**

All electrical equipment, apparatus and devices shall be of suitable design for satisfactory operation under the conditions prevailing at the Site. The equipment shall operate satisfactorily under normal load and voltage variations in accordance with IEC Publications.

The design shall also include all necessary provisions ensuring the safety of the operating and maintenance personnel.

All electrical connections and contacts shall be of ample cross section and capacity for carrying continuously the specified currents without undue heating and shall be secured by bolts or set-screws of ample size, fitted with locknuts or lock washers of approved types.

Unless otherwise expressly stated, conductors and all other current carrying parts shall be electrolytic copper in accordance with approved, applicable standards.

Cubicles and other enclosures containing electrical equipment shall be especially treated to prevent corrosion. All cubicles shall be provided with a door switched lighting fixture and a single phase socket for power outlet.

All interior surfaces of electrical apparatus, enclosures etc. including contactors, relays, coils, etc., shall be treated in an approved manner to prevent mould growth. Such treatment shall in no way interfere with the proper operation of the equipment either electrically or mechanically.

Bigger assemblies such as switchboards, etc., shall be designed to present suitable transportation divisions adapted to the local conditions within the plant.

Unless otherwise specifically called for or described in these Contract Documents all electrical appliances shall conform to the applicable IEC Publications.

16.2 **Construction requirements**

All cubicles and enclosures shall be of good quality standard production subject to approval by the Owner. Cubicles shall be free floor standing type, of rigid frame covered with removable steel sheets. The frame shall be bolted to the floor. There shall be provision and enough space for entrance of cables from above or below as necessary. The cubicles shall be ventilated if needed; in this case removable filter inserts shall be fitted to the air entrance openings. Provision for cable fastening shall be inside the cubicles and enclosures, and sufficient space from cable fastenings to nearest terminal. All control and indicating instruments such as contactors, circuit breakers, auxiliary relays, indicating instruments, switches etc., shall be functionally displayed in appropriate location. All indicating devices shall be visible with the door closed. The layout is subject to the approval of the Owner.

If required, flush mounted hinged steel doors with latches shall be available: doors shall be with approved locks. The locks shall be of the same type throughout the plant. All panels and cubicles shall have a uniform appearance.

The cubicles and enclosures shall be of protection class IP 54 or higher according to their location, unless otherwise, there are constraints which may prevent to maintain above protection class and same shall be justified by the contractor and approval shall be taken from the owner for the deviation. All cubicles shall be equipped with automatically controlled heating elements for protection against internal condensation and moisture.

All panels/cubicles shall have approximately 20% space for mounting of future devices.

16.3 **Wiring**

Wiring within cubicles and equipment enclosures shall conform to requirements of this section unless otherwise specified. Control wiring shall be stranded copper and shall be not smaller than 2.5 mm2, except as otherwise agreed by the Owner. Larger size wiring shall be used where needed for the current carrying capacity requirements.

Cables shall have at least 1100 V PVC insulation except for 220V DC and telemetering or communication system equipment for which 650V and 300V rating respectively are acceptable. .

For current and potential transformer secondary circuits the cross section of the conductors shall not be less than 6 mm2 and 4 mm2 respectively.

Wiring shall terminate at terminal blocks at one side only. Where tap connections are required they shall be made on terminal blocks. Wiring shall be neatly arranged and laid in conduits accessible from the front door. The conduits shall not be filled more than 70%.

Each cubicle shall be provided with an earthing bar (PE) of sufficient cross section carrying any possible fault current without undue heating. All metallic parts of the cubicle not forming part of the live circuits, all instrument transformer terminals to be earthed and other earthing terminals as well as all cable screens and PE-wires shall be connected to the earthing bar.

16.4 **Terminal blocks**

The terminal blocks shall be located to allow a neat and easy connection work and shall be safely accessible while the equipment is in service. Control circuits and power circuits shall be completely separated by use of divided or separate terminal blocks. Power terminal blocks shall be rated in accordance with applicable standards, and shall be provided with covers. Control wiring terminal shall be equipped with facilities for opening the circuit. It shall be possible to interchange a single terminal block for a new one without dismantling a whole row. Current transformer terminal blocks shall have provisions for short circuiting. Not more than two wires shall be connected to any

one terminal. Terminal blocks using screws acting directly on the wire will not be accepted. At least 20% spare terminals shall be provided. Terminals shall be marked with printed labels.

16.5 **Grounding**

The Contractor shall connect all equipment included in the scope of delivery to the grounding system of the Powerhouse, transformer substation and the switchyard. Two grounding mat i.e. power house grounding and transformer substation grounding shall be connected for effective grounding system. If necessary, third grounding mat shall be laid at T.R.T. outlet and shall be interconnected. In addition to the grounding through cable screens, all equipment such as cubicles, motors, etc. shall be connected directly to the grounding system using copper wire of area not less than 50 mm2 at two different points. In general all iron parts such as supports, covers, railing, etc. shall be connected to the grounding system. Each conductor shall have its own separate connection point. Pressed on closed shoes shall be used for connections to bars.

16.6 Protection devices

For short circuit and overload protection of lower rating power and control circuits, moulded case circuit breakers and MCBs respectively shall be used.

Outlets from AC (and DC) distribution panels are protected in their respective panels.

16.7 Marking of equipment and wiring

All internal equipment and wiring shall be neatly and clearly marked as indicated on the schematic and wiring diagrams. Internal wiring and cables shall be marked with sleeve type engraved marking. Marking system and marking material shall be subject to approval by Owner. Identification of the respective conductors shall be in accordance with the requirements of IEC publication 204. In cable having 5 conductors or more the individual conductors shall be numbered throughout the entire length. In cables having less than 5 conductors colour coding in accordance with IEC Recommendations 204 shall be used.

16.7.1 Colour Coding for Electrical Connections

Live parts of electrical connections shall be colour coded as follows:

Conductor Designation	Coding Alphanumeric	Symbol	Colour
A.C. network	phase 1	R	red
3 phase	phase 2	Y	yellow
	phase 3	B	blue
	neutral	N	black
A.C. single phase	phase	P	red
	neural	N	black
	earth	E	green-yellow
D.C. network	positive	a	red

negative	b	black

16.7.2 **Colour Coding for Mimic Diagrams**

Mimic diagrams to be arranged on switchgear cubicles, control panels/desks, etc., shall be colour coded as follows:

420 kV	Gold
13.8 KV	signal red
415 V	black
220 V D.C.	violet
48 V D.C.	white

Note: Colours given under 2.17.7.1 and 2.17.7.2 shall be finally agreed upon during detailed design.

16.8 **Compatibility**

Equipment serving similar or same purpose shall as far as possible be of same make and type. All indicating lights shall use same type of light bulbs.

17.0 **Cable Laying**

Wiring between equipment enclosures shall be made with cables, laid in trenches and/or cable trays and in cable conduits. The Contractor shall submit for review to the Owner a cable route layout showing location of trenches, conduits and trays. All material for cable laying such as cable trays supports and fastening material shall be furnished and placed by the Contractor. Cables shall be properly fastened and marked where they enter enclosures either by cable clamps or nipples. Cables in horizontal cable trays shall be fastened properly with clamps or plastic strips. Power and control cables shall be placed in separate trays or conduits. Cables shall be clearly marked at each terminal point.

18.0 **Control Concept**

The operations, control procedures, monitoring and protective devices for the plant are described in chapter of, Control and Monitoring system and protection system. The Contractor shall furnish all equipment required for effecting the intended method of operation and control, within the plant.

Primarily, control of equipment shall be automatic, but manual control and/or local control of the various components shall also be possible from control boards during operation, testing and maintenance of the respective components. Interlocking devices shall be incorporated in the control circuits in the quantity needed to guarantee correct sequence of operation of the equipment. Protective devices shall be supplied and the particular needs of equipment furnished with the aim of ensuring a safe and reliable operation of the plant in the event of electrical and mechanical disturbances or in case of mal-operation by the plant personnel.

In the design of the control systems for different parts of the plant the Contractor shall take care of standardizing the components used.

Where programmable logic controllers are used these shall to the extent possible be compatible. Where control systems are based on relays, sufficient information on the operating status shall be provided through potential free change-over contacts connected to outgoing terminals for comfortable connection.

19.0 Handling Devices

Lifting lugs, brackets, eyes, and other items required for attaching lifting devices shall be provided on all of the major components of the equipment weighing more than 25 kg. All slings and lifting devices required for attachment to the components and assemblies and to a crane hook for handling during erection and later disassembly shall be furnished.

20.0 Control Switches, Indicating Lamps and Instruments

20.1 General

Control switches, indicating lamps and instruments shall be arranged so that all parts are readily accessible for servicing without the necessity to remove other devices, terminal blocks or excessive amount of wiring.

All control switches and indicating devices mounted in cabinets and enclosures shall be visible with the doors closed.

Identification nameplates shall be provided for all control switches, indicating instruments and lamps, in accordance with clause 2.22, Nameplates.

Instruments and controls shall be located so that their dials, indicators and nameplates are clearly readable. Data for all instruments to be provided, including type, size, scale range, electrical ratings, nameplate and name of manufacturer, shall be furnished. Steel panels shall be provided for group mounting of the instruments. All instruments shall be of an approved type and shall match, insofar as practicable, the other instruments with which they are associated; their dial type, scaled markings and units, type of connection and mounting, shall be coordinated. All piping and tubing required for instruments shall be furnished and installed.

All instruments and control switches shall be furnished with necessary auxiliaries, i.e. resistors, shunts etc.

20.2 **Control switches**

The switches and push-buttons shall be provided with ample contact ratings, suitable cam or block arrangements necessary for the control functions on 415 V AC or 220 V DC circuits. The control switches used in mimic diagrams shall be of discrepancy type with built in lamp indication.

20.3 **Indicating and signalling lamps**

Each indicating and signalling lamp shall have a removable cap which can be inscribed with wording and shall not be affected with the heat of the lamp. Light bulbs shall be replaceable from the front of the panel. The indicating and signalling lamps shall be of the same size and type.

20.4 **Integrating instruments**

The WH and VARH meters shall be of the semi-flush-mounted type. Each meter shall be connected to terminal blocks suitable for opening and short circuiting for testing purposes. The meter cases shall be dust-tight and with removable covers. The meters shall be three-phase, three element, equipped with an impulse contact mechanism, potential free for remote metering purposes, and shall be suitable for continuous operation from secondaries of potential transformers and from secondaries of current transformers. The meters shall be provided with primary-rated, direct reading registers, with five or more dials or digits and a suitable multiplier. The meters for the outgoing lines shall be of the two-way type and all meters shall have mechanism to prevent negative registration.

The meters shall have built in over-voltage protection and an isolation according to IEC Publication 521. The tolerance ambient temperature range of the meters shall be 0 to 50 degrees C.

The class of the WH meters shall be 0.2 and the VARH meters 0.5 according to IEC Publication 687 unless otherwise stated in the particular technical specifications.

20.5 **Measuring converters**

The converters shall be suitable for direct connection to the secondary circuits of the potential and current transformers used, or other sensors, each as they apply. The converters shall be static type, having all accessories to provide and output signal of 4-20 mA, filtered DC. Power supply voltage used.

For the measuring converters the following minimum requirements shall be fulfilled :

- Current transducers shall be single-phase, of accuracy class 0.5 or better.
- Voltage transducers shall be single-phase of accuracy class 0.5 or better.
- W and VAR transducers shall be two element, three-phase. Accuracy class of the transducers shall be 0.5 or better.

20.6 **Measuring Transformers**

Potential transformer secondary windings shall be rated $110/\sqrt{3}$ V

Current transformer secondary windings shall have a rated current of 1A/ 5A.

21.0 **Nameplates**

Each major and auxiliary item of equipment shall have a nameplate permanently affixed thereto, or as directed, showing in a legible and durable manner the serial number, name and address of the manufacture, rated capacity, speed, electrical characteristics, and other significant information, as applicable. Nameplates of distributing agents only will not be acceptable. Nameplates shall also be provided for identification of all panels, cubicles and other enclosures as well as for panel-mounted devices, dials, gauges instruments and control devices. Nameplates shall be marked with the nomenclature and units of measurement used in the metric system (SI- units), and a schedule of such markings shall be submitted for review. Type of nameplates and wording on identification nameplates shall be submitted in English for approval. The Owner will translate the text if needed and the Contractor shall furnish and attach the nameplates.

21.1 **Cautionary signs**

English shall be used as prime language on nameplates required for caution or warning signs, identification plates for control devices, and instruction plates.

21.2 **Other nameplates**

Nameplates which are not required for the operation of the equipment and are not of a cautionary or warning nature required for the safety of personnel, i.e. showing motor speeds, horsepower, electrical characteristics, name and address of manufacturer and other information necessary for maintenance and repair work are to be in English.

22.0 **Equipment Service Conditions**

All equipments and material supplied under this contract shall be suitable for operation under the following service conditions

23.0 **Model, routine and type tests:**

23.1 Model Test shall be performed on Turbine as per clause 2.1.4.6 of the Technical Specifications. Prices quoted for Turbine shall, therefore, be inclusive of the cost of performing the model test.

23.2 Type Tests shall necessarily be performed on 17.5 KV Bus Duct and one of the 46 MVA single phase Step Up Transformers as per relevant IEC as stipulated in Chapter-4 and 5 of the Technical Specifications respectively. Prices quoted for these two items of equipment shall, therefore, be inclusive of the cost of performing these Type Tests.

24.0 Spare Parts and Tools

24.1 Spare Parts

24.1.1 All spare parts to be supplied shall be interchangeable with the corresponding parts of all the plant supplied under these Specifications and shall be of the same material and workmanship. They shall be replaceable without cutting or destruction of adjacent components. Before issue of the Taking-Over Certificate the spare parts shall be checked and tested at the Site by the Contractor in presence of the Purchaser.

24.1.2 Acceptance of any spare parts will not take place before the Contractor has submitted the complete final detailed list of all spare parts and tools.

24.1.3 All spare parts shall be protected against corrosion and shall be marked with identification labels in the English Language. The identification shall be in accordance with the agreed Plant Identification System.

24.1.4 All spare parts, tools and materials shall be delivered in marked boxes of sufficient sturdy construction to withstand long term storage. The Contractor shall label and conveniently store all

spare parts in racks provided by him in ready to use manner before handing over to the Purchaser.

24.2 Mandatory Spare Parts

24.2.1 At least the quantity of mandatory spare parts required for successful operation and maintenance of the plants and equipment for a period of 5 years shall be included in the Total Tender Price and consequently in the Scope of Works of the Contract.

24.3 Recommended Spare Parts

24.3.1 If any additional spare parts are recommended by the Contractor, these shall be stated in quantity and description in the Technical Data Sheets for each item.

24.3.2 Prices for additional recommended spare parts shall not be included in the Total Tender Price for evaluation purpose.

24.4 Mandatory Tools and Appliances

24.4.1 Contractors shall supply all mandatory tools & appliances as specified in technical specification. Contractor shall also suggest any addition and deletion in the list specified by the purchaser required for total assembly and disassembly of all parts of the supplied plant and accessories for maintenance of the plant.

24.5 **Recommended Special Tools and Equipments**

24.5.1 The Contractor shall have to furnish the list of recommended special tools and equipments. Prices for recommended special tools & equipments shall not be included in the total tender price.

24.5.2 Foreign bidder shall identify the indigenous source (within the country of operation of the unit) for supply of spares and indicate the same in their offer.

25 **TECHNICAL/DESIGN CO-ORDINATION MEETING**

25.2 The Contractor shall be called upon to organise and attend monthly Design/ Technical Co-ordination Meetings(TCMs) with the Employer/Employer's representatives and other Contractors of the Employer during the period of contract. The Contractor shall attend such meetings at his own cost at project site or at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during the discussions.

25.3 The Contractor should note that Time is the essence of the contract. In order to expedite the early completion of engineering activities, the Contractor shall submit all drawings as per the agreed Engineering Information Submission Schedule. The drawings submitted by the Contractor will be reviewed by the Employer as far as practicable within three (3) weeks from the date of receipt of the drawing. The comments of the Employer shall then be discussed across the table during the above

Technical Co-ordination Meeting (s) wherein best efforts shall be made by both sides to ensure the approval of the drawing.

25.4 The Contractor shall ensure availability of the concerned experts / consultants/ personnel who are empowered to take necessary decisions during these meetings. The Contractor shall be equipped with necessary tools and facilities so that the drawings/documents can be resubmitted after incorporating necessary changes and approved during the meeting itself.

25.5 Should any drawing remain unapproved for more than six (6) weeks after it's first submission, this shall be brought out in the monthly Engineering Progress Report with reasons thereof.

25.6 Any delays arising out of failure by the Contractor to incorporate Employer's comments and resubmit the same during the TCM shall be considered as a default and in no case shall entitle the Contractor to alter the Contract completion date.

26 DESIGN IMPROVEMENTS

26.2 The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes the specification shall be modified accordingly.

26.3 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any changing the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

27 QUALITY ASSURANCE PROGRAMME

27.1 The Contractor shall adopt suitable quality assurance programme to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before the award of the contract. The QA programme shall be generally in line with IS/ISO-90021. A quality assurance programme of the contractor shall generally cover the following:

i) His organisation structure for the management and implementation of the proposed quality assurance programme

ii) Quality System Manual

iii) Design Control System

iv) Documentation and Data Control System

v) Qualification data for Bidder's key Personnel.

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

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

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

ix) Inspection and test procedure both for manufacture and field activities.

x) Control of calibration and testing of measuring testing equipment.

xi) System for Quality Audits.

xii) System for identification and appraisal of inspection status.

xiii) System for authorising release of manufactured product to the Employer.

xiv) System for handling, storage and delivery.

xv) System for maintenance of records, and

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

27.2 General Requirements - Quality Assurance

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

27.2.2 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's/ Sub-contractor's/ sub-supplier's Quality Control Organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and

final testing/performance testing. The Quality Plan shall be submitted on electronic media e.g. E-mail in addition to hard copy, for review and approval. After approval the same shall be submitted in compiled form on CD-ROM.

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

27.2.4 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points i.e. test/checks which shall be carried out in presence of the Employer's Project Manager or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval.

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

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

27.2.7 The contractor shall submit to the Employer Field/Site Welding Schedule for field welding activities. The field/site welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, procedures etc. at least ninety days before schedule start of erection work at site.

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

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

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

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

27.2.12 Any other statutory requirements for the equipment/systems shall also be complied with. On all back-gauged welds MPI/LPI shall be carried before seal welding.

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

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

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

27.2.16 The Contractor shall list out all major items/ equipment/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion.

27.2.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract

between the Contractor and sub-contractor. With in three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor .

27.2.18 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

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

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

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

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

27.3 QA Documentation Package

27.3. 1 The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (□) mark.

27.3.2 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

27.3.3 The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

27.3.4 The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD-Rom may be issued not later than three weeks.

27.3.5 Typical contents of QA Documentation is as below:-

i) Quality Plan

ii) Material mill test reports on components as specified by the specification and approved Quality Plans.

iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

iv) Non-destructive examination results /reports including radiography interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

v) Heat Treatment Certificate/Record (Time- temperature Chart)

vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).

vii) Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

viii) Certificate of Conformance (COC) wherever applicable.

ix) Material Despatch Clearance Certificates (MDDC)

27.3.6 Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

27.3.7 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

ii) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

iii) If a decision is made to despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify of the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

28 Engineer-In -Charge Supervision

28.1 To eliminate delays and avoid disputes and litigation, it is agreed between the parties to the Contract that all matters and questions shall be referred to the Engineer-in-charge and without prejudice to the provisions of 'Arbitration' clause in GCC of Part-1: bidding procedures of the Bidding Document, the Contractor shall proceed to comply with the Engineer-in-charge decision.

28.2 The work shall be performed under the supervision of the Engineer-in-charge. The scope of the duties of the Engineer-in-charge pursuant to the Contract, will include but not be limited to the following:

i) Interpretation of all the terms and conditions of these documents and specifications:

ii) Review and interpretation of all the Contractor's drawing, engineering data, etc:

iii) Witness or his authorised representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract :

iv) Inspect, accept or reject any equipment, material and work under the contract :

v) Issue certificate of acceptance and/or progressive payment and final payment certificates

vi) Review and suggest modifications and improvement in completion schedules from time to time, and

vii) Supervise Quality Assurance Programme implementation at all stages of the works.

29 Measuring Systems

29.1 General

29.1.1 Only electric measuring signals of 4 – 20 mA shall be transmitted to the control room. The output signal of transmitters shall be 4 – 20mA and linear over the whole measuring range.

29.1.2 The components shall quickly respond to any changes of the measured magnitudes. Measuring ranges of indicators, transducers, etc., shall be selected in such a way that the rated

value of the measured magnitude covers approx. 75% of the range.

29.1.3 All local instruments shall, as far as practicable, be mounted vibration free to allow good reading. Wherever required, damping elements shall be used.

29.1.4 Corresponding systems shall be grouped together in local panels.

29.1.5 All local indicating instruments and test connections shall be included in the respective plant as integrated parts. The scope of local indicating instruments and test connections shall enable the operator to properly survey the plant, and shall also allow to adequate carry out all acceptance and other tests.

29.1.6 The binary sensors shall be fused separately and supplied with 24 V DC.

29.2 Flow Measurements

29.2.1 Flow meters shall be of electromagnetic type with high vacuum and abrasion resistance interior.

29.2.2 One NO and one NC snap action contacts shall be provided for maximum and minimum values. Error limit shall be less than 5% of the measured value.

29.2.3 The design and arrangement of tapping points, piping and valves shall be in accordance with relevant Indian Standards / VDI / VDE 3512.

29.3 Temperature Measurements

29.3.1 All wells for capillary type thermometers, resistance temperature sensors and thermocouples shall be of the weld-in type. Wells for thermometers and temperature sensors of the screw-in type shall be restricted to measuring points for lubrication oil, and to such measuring points where welding is not suitable, e.g., at cast-iron parts. Shop-welded thermometer wells be covered by screw caps for protection during transportation and erection.

29.3.2 Resistance thermometers and thermocouples shall be equipped with waterproof connection heads. Thermometer arrangements shall be such that the connection heads do not become warmer than $80^{O}C$, and the measuring inserts are easily exchangeable.

29.3.3 The temperature sensors shall be selected in such a way to minimize the number of different spare inserts.

29.3.4 Resistance temperature detectors shall be standard type platinum, (100 ohm at zero degree centigrade). The wire of resistance shall be wound on ceramic base. The RTD protecting tube shall be of the pipe thread screw-in type.

29.3.5 Temperature to be recorded shall be measured by means of resistance thermometers or thermocouples which can directly be connected to the recorders.

29.3.6 The use of dial-type contact thermometers shall be restricted to bearing metal, cooling water and oil temperature measuring. In

all other cases, thermocouples or resistance thermometers and electric contact modules (monitors) shall be used. Glass thermometers or similar will not be accepted as contact thermometers.

29.4 Transuducers

29.4.1 The transducers shall be solid- state type with an output signal range of 4-20 mA DC or 1 to 5 V DC, unless otherwise specified.

29.4.2 The rms ripple current shall be less than 1 (one) percent within the rated measuring ranges.

29.4.3 Each transducer shall be able to operate upto a load impedance ranging between 0 to 500 ohm without adjustment of output. Transducers shall have a minimum adjustment of output current $\pm$ 5 %.

29.4.4 The transducers and their power supplies shall be designed so that no appreciable deviation in the output current is produced switching or other voltage transients in the supply. The output leads from the transducers to the main terminal block shall be shielded.

29.5 Pressure Measurement

29.5.1 Pressure gauges shall be shock and vibration-proof (preferably by filling with glycerine) and shall be equipped with toothed wheels and toothed segments of the machined type. They shall completely be made of stainless steel.

29.5.2 Higher than rated pressure shall not deteriorate the pressure gauge or affect its calibration. The pressure gauges shall be equipped with a radial connecting stud, to allow the mounting on a gauge holder.

29.5.3 Pressure gauges with potentiometers will not be accepted for use as a pressure transmitter.

29.5.4 The error for pressure transmitters shall be limited to + 0.5%.

29.5.5 Pressure gauges and transmitters for inflammable liquids shall have filled systems and the filling liquid shall be separated from the inflammable liquid by means of adequate isolating membranes.

29.5.6 Each gauge, pressure switch and transmitter for absolute or differential pressure shall be equipped with a pressure gauge isolating valve including a test connection of the screwed type M20 x 1.5mm so that such device can be removed without any disturbance of the plant operation.

29.5.7 Pressure gauges and transmitters for pressure of 10 bar and above, shall not be directly mounted on the pressure tapping point. They shall be mounted apart from the tapping point on gauge holders or gauge boards. Whenever possible, pressure gauges and transmitters shall be groupwise combined on racks or consoles.

29.5.8 Pressure gauges for high pressures shall be equipped with a relieve valve for safety reasons in case of leaks (with a rubber reverse flow check).

29.5.9 In case of flowing substances, the measuring point shall be selected in locations of undisturbed flow.

29.5.10 If the pressure is pulsating, the devices concerned shall be connected via flexible tubes or other pulse-absorbing means.

29.5.11 The design and arrangement of tapping points, piping and valves shall be in accordance with relevant Indian Standards / VDI/VDE 3512.

29.5.12 The scales shall have a diameter of 150mm with black letters and figures on a white ground. The calibration shall be in kg/cm2.

29.5.13 The high and low pressure connections of differential pressure gauges shall be marked accordingly.

29.5.14 All casings shall be dust proof and watertight and be made of stainless steel.

29.6 Vibration Measurements

29.6.1 The vibration probe shall be of Piezoelectric acceleration sensor or proximity type based on either eddy current or magnetic pickup. For reliability, it is always desired that two probes at right angles to each other shall be utilised.

29.6.2 The proximity vibration sensor shall be used for measuring the rotating parts vibration/runout. The sensor probe shall be electrically isolated where it is supported.

29.7 Level Measurements

The liquid level measurements in reservoirs and tanks with atmospheric pressure shall be made by means of pressure transmitter of mercuryless-type, by displacement-type transmitters or float-disc-transmitters. The errors shall not exceed $\pm$ 1.0% of the total measuring range. Level switches shall be of packless construction; there shall be a minimum of moving parts.

29.8 Electrical Measurement

29.8.1 All Electrical instruments shall be of flush mounted design, dust and moisture-proof. AC Ammeters and Voltmeters shall have moving iron system of not less than 1.5 accuracy class for connection to the secondary side of instrument transformers. DC measuring instruments shall have moving coil systems of the same accuracy. Wattmeters shall have electro-dynamic measuring mechanisms or alternatively a moving coil mechanism if fed by transmitters. Wattmeters shall be suitable for unbalanced system.

29.8.2 All indicating instruments shall generally withstand without damage a continuous overload of 20% referred to the rated output value of the corresponding instrument transformers. Ammeters shall not be damaged by fault-currents within the

rating and fault duration time of the associated switchgear via the primaries of their corresponding instrument transformers.

29.8.3 All instruments and apparatus shall be capable of carrying their full load currents without undue heating. All instrument and apparatus shall be rear connected, and the enclosures shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

29.8.4 All voltage circuits to instruments shall be protected by fuses in the unearthed phases of the circuit installed as close as practicable to the instrument transformer terminals or where instruments are direct-connected as close as practicable to the main connection. All power factor indicators shall have the star point of their current coils brought out to a separate terminal which shall be connected to the star point of the current transformer secondary windings.

29.8.5 When more than one measured value is indicated on the same instrument, a measuring point selector switch shall be provided next to the instrument and shall be engraved with a legend specifying each selected measuring point.

29.8.6 All instruments shall be of the flush mounting type and shall be fitted with non-reflecting glass and shall comply in every respect with the requirements of IEC 51. Except for instruments employed for plant performance tests all instruments shall have an accuracy class of 1.5.

29.8.7 Scales shall be arranged in such a way that the normal working indication is between 50-75% of full scale reading permitting an accurate reading. CT connected Ammeters provided for indication of motor currents shall be provided with suppressed overload scales of 2 times full scale. The dials of such Ammeters shall include a red mark to indicate the full load current of the motor.

29.8.8 Where directly connected Ammeters are provided for indication of motor currents they shall be supplied with overload scales indicting up to six times full load current. The dials of such Ammeters shall include a red mark to indicate the full load current of the motor.

29.8.9 Instrument scales shall be submitted for approval by the Purchaser. All instruments mounted on the same panel shall be of same style and appearance.

29.8.10 Transmitter connected Ammeters shall have 90^{O} or 240^{O} circular scales calibrated 0-120%. The rated motor current shall correspond to 100% scale indication.

29.8.11 Energy meters shall be of the induction disc type with limits of error according to IEC 170. The casings shall be dust and moisture-proof and shall fit into the boards to permit reading without opening the corresponding front door. Disc and cyclometers of the drum-type shall be clearly visible through a window in the casing and the cyclometer shall be able to record

for a minimum of 2.5 hours. Meters shall be suitable for unbalanced systems.

29.9 Digital type Instruments

The indicative element for each digital indicator shall be seven segment LED illumination type. The number of digits of each digital indicator shall be selectable to sent the required indication. The watt and the var indicators for the circuits where direction of power flow may be changed, shall be provided with "+" and "-" signs.

29.10 Position Measurements

Position transmitters of the potentiometer type will not be accepted. Inductive or capacitive type shall be provided.

29.11 Contact Devices

Contacts of level switches, pressure switches, limit switches, and of all other devices shall be of the snap action type (SPDT). Contact devices for interlocking systems shall be separate, i.e., contact devices serving commonly for interlocking and other purposes will not be accepted.

30 TRANSPORT AND INSTALLATION

30.1 The bidder is advised to have a total study of all aspects of transportation of equipments to site and should make schedule of transportation in accordance with the prevailing conditions at site. The bidder shall specifically understand that the Purchaser will do the general co-ordination of storage and erection works as well as civil engineering works of power house .An appropriate period for transportation shall be considered accordingly.

30.2 The Purchaser will do the general co-ordination of storage and erection work as well as the civil engineering work under the different packages on site.

30.3 The delivery dates, transportation and erection periods and for all other associated activities indicated in the Contract Documents shall be strictly adhered to. Changes, which are unavoidable or necessary, will be regulated in accordance with the stipulations laid down in the General Conditions of Contract.

30.4 From the time of manufacturing until commissioning all parts of the plant shall be protected and insured at the Contractor's expense against loss & damage of any kind. Parts, which are damaged during transport, storage, erection or trial operation, shall be replaced at the Contractor's expense.

30.5 Packing and Marking

30.5.1 The Contractor shall prepare all plant, devices and materials for shipment to protect them from damage in transit, and shall be responsible for and make good all damages due to improper preparations, loading or shipment.

30.5.2 After the workshop assembly and prior to dismantling for shipment to the Site, all items of machinery and plant shall be carefully marked to facilitate site erection. Wherever applicable, these markings shall be punched or painted so that are clearly visible.

30.5.3 Dismantling shall be done into convenient sections, so that the weights and sizes are suitable for transport to Site and for handling on the Site under the special conditions of the Project.

30.5.4 All individual pieces shall be marked with the correct designation shown on the Contractor's detailed drawings and other documents (packing, lists, spare part lists, in Operating and Maintenance Instructions, etc.).

30.5.5 Each piece, separately shipped, or smaller parts packed within the same case or box, shall be legibly, marked to show the unit to which it is a part and match-marked to show its relative position in the unit.

30.5.6 Unit marks and match-marks shall be done preferably by punching the marks into the metal before painting, galvanizing, etc., and shall be clearly legible after painting, galvanizing etc. In labelling, the Contractor shall endeavour to use as few designations as possible, and each part of identical size and detail shall have the same designation, regardless of its final position in the plant.

30.5.7 All parts of the plant shall be packed at the place of manufacture; the packing shall be suitable for shipment by sea and for all special requirements of the transportation to Site. Where necessary, double packing shall be used in order to prevent damage and corrosion during intermediate storage.

30.5.8 All identical members shall be packed together, if reasonably possible, in a form convenient for shipment and handling.

30.5.9 Small items shall be packed in boxes and large items shall be protected where necessary, by timber, straw and sacking. Drums shall be used for electric cables, steel ropes, steel wire and similar materials. All bolts, nuts, washers. etc., shall be packed in containers. Each container shall include only bolts, nuts or washers of identical size.

30.5.10 All parts shall be suitable protected against corrosion, water, sand, heat, atmospheric conditions, shocks, impact, vibrations, etc.

30.5.11 All electrical parts shall be carefully protected from damage by sand, moisture, heat or humid atmospheric conditions by packing them in high pressure polyethylene foil. Where parts may be affected by vibration, they shall be carefully protected and packed to ensure that no damage will occur while they are being transported and handled.

30.5.12 Spare parts shall be packed separately and designated as specified and shall be delivered properly and adequately

packed for several years' storage. All packing costs shall be included in the scope of Work.

30.6 Shipping Marks

The Contractor shall mark all containers with the implementing document number pertinent to the shipment. Each shipping container shall also be clearly marked on at least two sides as follows:

Consignee:

Contract No.:

Port of destination:

Item number (if applicable) Package number, in sequence and quantity per package:

Description of Works:

Net and gross weight, volume, Dimensions

30.7 Packing Lists

The Contractor shall provide the Purchaser with one (1) original and two (2) copies of all shipping documents and relevant packing lists of each shipment of equipment items after the same has been shipped. One copy (1) of the packing list shall sent to the Purchaser's Representative. All packing lists shall contain the name of the Contractor or supplier and shall show the complete markings on each packed box or crate that has been shipped. Separate packing lists shall be prepared for each and all shipments made. One copy of the packing list shall be placed inside each box or crate, and one copy inserted in a weatherproof envelope affixed to the outside of each box or crate.

30.8 Equipment Handling and Storage

30.8.1 All equipment shall be handled very carefully to prevent any damage or loss. Wires, chains, ropes slings etc. used for handling of the equipments shall be appropriately protected by sleeves or other means to prevent damage to the equipment.

30.8.2 The equipment stored shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the storage shall be moved to the actual location at appropriate time so as to minimize risk of damage of such equipment at site.

30.8.3 The Contractor shall provide means for all unloading and reloading for all consignments of plant, both during transport to Site and on the Site. Consignments shall be unloaded

immediately on arrival at Site. The Contractor is required to take the necessary steps in order to provide the carriage, special supporting structures for heavy loads, etc.

30.8.4 All large parts of the plant shall be brought, as far as possible and practicable, directly to their final place of erection.

30.9 Storage Area and Warehouses

30.9.1 The Purchaser will designate areas where the Contractor may store parts of the plant. The Contractor shall, at his own expense, render such areas suitable for the respective purposes.

30.9.2 The warehouses shall be weatherproof, with good ventilation and solid floors. The floors of the warehouses and storage areas shall be designed to carry the loads imposed on them by the stored parts. The following parts shall be stored inside enclosed warehouses:

i) Electrical parts with electrical devices attached, electric motors and excitation equipment

ii) Instruments, welding material and equipment, bolts, pins, packing, tools, insulation materials A

iii) All small parts and parts of the plant which already have been finally painted.

30.9.3 All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are put into storage. If panels equipped with anti-condensation heaters will be stored over longer period of time (more than one month), the Contractor shall assure that the heaters are energised.

30.9.4 Motor bearing slip-rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and motors shall be periodically rotated to prevent corrosion due to prolonged storage.

30.9.5 If large parts are stored in the open air, they shall be provided with weather resistant and fire-resistant covers. Electrical parts, which are not packed in heavy-duty polyethylene foil and those so packed, but whose packing has been damaged, shall be kept in suitable place from the moment of storage to the moment of installation.

30.9.6 All insulation materials which will be taken from the warehouse for installation and which are stored temporarily in the powerhouse shall be protected from weather or humidity.

30.9.7 The consumable and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage

30.9.8 The Contractor shall ensure that all the packing materials, and protection devices used for the equipment during transit and storage are removed before the equipment are installed. The packing materials and protection devices shall remain the property of the Purchaser and shall be handed over to him by the

Contractor after completion of the work. In case, the Contractor fails to return the packing materials and protection devices, the Purchaser shall have the discretion to deduct from the Contract price at a reasonable amount on this account.

30.9.9 If the materials belonging to the Contractor are stored in areas other than those earmarked for him, the Purchaser will have the right to get it moved to the areas earmarked for the Contractor at the Contractor's cost.

30.9.10 The contractor shall maintain an accurate and exhaustive record that details out the list of all equipment received by him for the purpose of erection and keep such record open for inspection of the Purchaser at any time.

30.10 Preparation of Site Installation Works

30.10.1 Prior to commencement of installation, the Contractor shall closely inspect the Site and all the foundations and other structures on which parts of the plant supplied under this Contract will be installed; he shall check that the foundations conform to the installation drawings.

30.10.2 The result of this check shall be reported to the Purchaser in due time to allow any errors to be corrected before the commencement of erection. All parts of the plant shall be cleaned carefully of all contamination such as dust, sand, rust, mill scale and other dirt prior to installation.

30.11 Reference Points

30.11.1 The Purchaser will provide major centre lines and datum levels only. The Contractor shall be responsible for transferring those required to carry out the Works. The Contractor shall employ a competent surveyor for setting-out of all datum lines including the constant checking and maintenance of the setting-out until the completion of his works.

30.11.2 The Contractor shall provide all necessary pegs, profiled templates and centre lines and shall establish all such permanent markings and recovery marks as may be required by the Purchaser for checking the Contractor's setting-out. The Contractor shall be responsible for rectifying, at his own cost, all work rejected by the Purchaser due to errors in setting-out.

30.11.3 All bench marks, kerb marks, pegs and signals on the surface, alignment pins and the like put in by the Purchaser for the purpose of checking the Contractor's work or as permanent survey marks will be under the care of the Contractor during the period of the Contract. He shall, at his own expense, take all proper and reasonable care and precautions to preserve and maintain them in their true position where such marks are within or adjacent to his work area. In the event of their being disturbed or obliterated by any cause whatsoever, they may, if so determined by the Purchaser, be replaced by the Purchaser at the Contractor's expense.

30.11.4 The Contractor shall be responsible for the true and proper staking-out of the works and levels of reference given by the Purchaser in writing, for the correctness of the positions, levels, dimensions and alignment of all parts of the works and for the provision of all necessary instruments, appliances and labour in connection with this.

30.11.5 The checking of any staking-out or of any line or level by the Purchaser or the Purchaser's Representative shall not in any way relieve the Contractor of his responsibility for its correctness.

30.12 Installation Work

30.12.1 All transportation and handling of the plant from the place of storage to the place of installation shall be carried out by the Contractor. He shall also provide all hoisting equipment, staging and scaffolding, winches and wire ropes, slings, tackles and all other appliances and temporary materials. The erection staging and scaffolding shall be provided with coverings and barriers and shall guarantee safe working conditions.

30.12.2 The Contractor shall comply with all applicable and approved safety regulations while carrying out the works at Site and with all reasonable requirements of the Purchaser. This stipulation shall in no way release the Contractor from any obligation concerning his liability for accidents and damage. He shall be responsible for adequate protection of persons, plant and materials against injuries and damages resulting from his operations.

30.12.3 The plant or parts to be installed shall not be over-stressed during the process of installation.

30.12.4 The Contractor shall be responsible that the installation of all plants is properly executed to the correct lines and levels and in accordance with the manufacturer's instructions and the Contract requirements.

30.12.5 The alignment of the plant shall be done exactly; the tolerances indicated by the Manufacturers or in the drawings shall be kept.

30.12.6 Setting of parts to be aligned shall be performed by means of fine measuring instruments. All erection clearances and settings shall be given to the Purchaser. After alignment, the parts shall be held firmly in position by means of set pins, fitted bolts, etc.

30.13 Embedded Parts

30.13.1 Anchor bolts, base plates, anchor rails, etc. to be embedded in the first stage concrete shall be delivered in due time with instructions and/or templates to facilitate the bringing in of such parts into the Civil works.

30.13.2 All parts to be embedded in concrete shall be set accurately in position and shall be supported rigidly to prevent displacement during the placing of concrete. Adjusting screws and bolts shall be drawn tight and secure adequately. Steel wedges shall be secured by welding. Wooden wedges shall not be used.

30.13.3 The Contractor shall verify carefully the position of all parts to be embedded before concrete is poured. All important measurements and dimensions shall be recorded. Copies of these records shall be given to the Purchaser for checking and approval before items are built-in to the works.

30.14 Temporary Bracing

30.14.1 The Contractor shall provide all necessary anchors and braces to ensure the alignment and stability of the parts to be installed. All temporary anchors and bracings shall take care of all dead load, wind load, ice load, seismic and erection stresses, e.g., during concreting, and shall remain in place until they can be removed without endangering the stability of the plant.

30.14.2 Temporary bracing and attachments shall be fixed and removed in such a way as to prevent damage occurring to the base metal to which they are attached. Projecting welds remaining after this operation shall be ground flush. Tears in the base metal shall be filled with weld and ground flush. After completion of work, the surface shall be restored to proper condition by grinding and repainting.

30.14.3 Welding, torch-cutting and drilling work on the plant to be erected shall only be carried out with the approval of the Purchaser.

30.15 Workmanship

30.15.1 Special care shall be taken not to damage surfaces of galvanized or specially treated plant during erection. Care shall be taken to prevent or remove any rust streaks or foreign maters deposited on galvanized or otherwise finished surfaces during storage or transport or after installation.

30.15.2 Glass parts of other parts which can easily be damaged shall be provided with suitable protective sheaths or coverings during installation.

30.15.3 Machined or bare metal surfaces that are not painted shall be protected during transportation, storage and erection by a suitable anti- corrosion film.

30.15.4 All portable power tools shall preferably be operated pneumatically.

30.15.5 Special tools which are supplied for maintenance and repair can be used for installation. They are to be handed over at the end of the installation work in good condition in accordance with the Purchaser's instruction.

30.15.6 After erection, the works shall be finally painted; it shall be done as far as applicable in accordance with the painting specification, and any damaged paint-work be restored.

30.16 Modifications, Rectifications and Re-Erection

30.16.1 If the dismantling, modifications, rectification, addition etc. is necessitated due to any mismatch/discrepancy in the

fabrication drawing prepared by the Contractor or in fabrication, the Contractor shall be held responsible for the same despite the fact that such drawing might have been approved by the Purchaser. In such cases, nothing extra shall be payable to the Contractor towards carrying out such modification, rectification, addition, dismantling testing, transportation and any other allied activity.

30.16.2 In case, it is found that certain erection marks as already detailed and approved in fabrication drawings require addition, alternation and modification, the same shall be done on the written orders of the Purchaser or his authorised representative.

30.16.3 The work of re-erection include carriage of modified erection marked members from fabrication shop to erection site, lifting of the same to the required position, aligning, erection in position inclusive of bolts and touch up pointing etc. complete to the satisfaction of the Purchaser.

30.16.4 The quoted price shall include all these operation.

30.17 Foundation Bolts

30.17.1 Foundation bolts for bus structure and elsewhere shall be embedded in first stage concrete while foundations cast. The bolts may be provided in pipe sleeves permitting adjustments in the proper alignment of these bolts to match holes in the structure basis. The final adjustment of these bolts and their grouting and provision of shiner for correct erection of structure is to be included in the unit rate of items of structural steel.

30.17.2 The Contractor shall be responsible for the correct alignment and levelling of all steel works on Site to ensure that the columns/towers and structures are plumb.

30.17.3 Before erection of columns/towers/structures on the foundations, the top surface of base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material and shall be chipped with chisel to ensure proper bond between the ground and foundation concrete. The Contractor shall also be responsible for bringing the top of concrete to the desired level by chipping. In case foundation as cast in lower than the desired level. The Contractor shall make up the difference by providing additional pack plates and shims without any extra payment for any such work or materials.

30.17.4 No steel structures shall be put on foundation unless such foundations have been certified fit for erection of steel by the Purchaser. Adequate number of air release holes and inspection holes shall provided in the base plate.

30.17.5 Foundation bolts for the structures shall be supplied by the Contractor.

31 INSPECTION AND TESTS

31.1 In addition to the provisions established in the Conditions of

Contract regarding general procedure of inspections and tests, terms and definitions, and time schedules for inspections and tests the following stipulations shall apply.

31.2 Purchaser reserves the right to ask for the valid calibration certificate for any instrument to be used for testing or may get the instrument tested by any independent agency.

31.3 Type Tests / Routine Tests / Acceptance Tests / Site Tests

31.3.1 For the specified type tests certificates for the same equipment type, not older than ten years from the date of signing the Contract, shall be submitted for approval by the Purchaser. In case that the test certificates are older than ten years the Contractor shall carry out the specified type tests at his own costs.

31.3.2 Contractor shall have to do all the routine tests, acceptance tests & site tests required as per technical specification & Indian Standards / International Standards.

31.3.3 Contractor shall have the access to the required facilities as stated in the relevant standards to carryout the tests on the various equipments.

31.3.4 In case, contractor does not have the facility to carryout any of the test and intends to carryout the same at some other agency those testing agencies shall be got approved by the purchaser.

31.4 Workshop Inspections and Tests

31.4.1 As far as practicable, quality of materials, workmanship and performance of all items of the work and plant to be furnished under this Contract shall be inspected at the places of manufacture.

31.4.2 When placing orders for material and plant with Sub-suppliers, the Contractor shall send unpriced copies of such orders in triplicate to the Purchaser.

31.4.3 Arrangements shall be made for expediting the shop inspection by having all shop assemblies or pieces covering a single shipment ready at one time. Any painting work as well as transport to the Site of the plant shall not be started before the approval of the Purchaser has been obtained.

31.5 Material Tests

31.5.1 Unless otherwise specified, the quality of materials shall be verified generally by:

chemical analysis	
mechanical tests	(yield point, tensile strength, elongations, notch impact strength, etc.)

welding tests	(welding procedure, welding material, welding tensile strength, welding bend test, welding reversed bend test, etc.)
non-destructive tests	(x-rays, ultrasonic, magnaflux, liquid penetration inspection, etc.)
electrical tests	(voltage, losses, tan delta, insulation, magnetic properties, etc.).

31.5.2 Certified mill test reports of plates will be acceptable when these comply with the requirement for "Reports of Inspections and Tests" as stated in the Special Conditions. Test specimen and samples for analysis shall be plainly marked to indicated the materials they represent.

31.5.3 Castings and forgings shall be tested in the rough state in order to detect flaws in good time thus avoiding delays. Magnetic particle inspection of important castings shall over the whole surface of the casting. After partial machining further tests can be conducted.

31.5.4 Load tests on crane hooks, steel wire ropes, chains, etc. shall be considered as material tests.

31.6 Checking of Dimensions

31.6.1 The dimensions, especially clearances and fits, (ISO 286) which are essential for operation and efficiency shall be carefully checked in an approved manner, as for example:

i) runout and roundness tolerances of shafts. Rotors, pistons, etc., to be measured on single parts as well as (wherever possible) on the assembled components

ii) fits and clearances of bearings, runners, rotors, servomotor pistons, valves, guiding, distributing and actual actuating elements, etc.

iii) accuracy, surface roughness and shape of sliding and guiding surfaces of seals, bearings, water passages in hydraulic machinery, valves, etc.

iv) profiles of turbine runners, pump impellers, etc. to be checked by means of templates

v) dimensions of couplings or connections for assembly with other deliveries from the Contractor, Sub-contractors or other contractors.

31.7 Shop Assembly

31.7.1 In addition to the quality and production control tests, the following shop assembly work and tests shall be made to check measurements, fitting and functioning.

31.7.2 Plant to be furnished shall be shop assembled to a status sufficient to prove that the design and workmanship have been executed in accordance with the Specifications, that the delivery is complete, and that no work remains to be done at Site which reasonably can or should be done in the shop.

31.7.3 Where applicable, each item of the plant shall be assembled completely prior to painting.

31.7.4 Field joints shall be temporarily connected.

31.7.5 All parts shall be properly match marked, identified and doweled where practicable, to facilitate correct and quick field assembly and alignment. Wherever necessary, suitable dowels shall be provided for insertion after field assembly and drilling. The holes for any fitted bolt shall be accurately reamed.

31.7.6 During shop assembly all instruments, control devices and piping shall be fitted.

31.7.7 If the corrections cannot be carried out in accordance with the terms mentioned above, the components concerned will be rejected. The decision on possible subsequent corrections is reserved exclusively to the Purchaser. Faulty parts or plant shall by no means be delivered.

31.7.8 The assembled parts shall subsequently be subjected to tests as per applicable standards of required by the Purchaser.

31.8 Pressure and Leakage Tests

31.8.1 All parts subject to internal or external pressure or containing any liquids of gases temporarily or permanently during operation shall be tested prior to painting. As far as practicable, these tests shall be done in the shop but can be repeated at Site.

31.8.2 Parts exposed during operation to hydraulic pressure, to gas pressure or to any liquid without pressure, shall be treated distinctively.

31.8.3 In addition to the Specifications, the applicable and approved standards and official regulations shall be observed. If any liquid is used for the test that may cause corrosion, all plant and piping shall be thoroughly cleaned immediately after the test.

31.8.4 As far as practicable and required, the influences of temperatures and temperature differences to which the part will exposed during operation shall be considered in the execution of the tests.

31.8.5 Leaks and defects can be repaired if permitted by the applicable standard and approved by the Purchaser. If defects are found, the Purchaser may reject the defective parts, or permit welding repairs with stress relieving, radiographic examination and additional pressure tests.

I) Parts Exposed to Hydraulic Pressure

31.8.6 Unless otherwise specified or required, the following shall apply: the hydraulic pressure tests shall be carried out using the liquid to be used during operation or a liquid with less viscosity.

31.8.7 The hydraulic test pressure shall be 1.5 times the maximum operating pressure and shall be maintained for a period of two hours or longer if required by the applicable standards. Afterwards the test pressure shall be reduced to the operating pressure.

31.8.8 The welded seams of large parts which are not subjected to any heat treatment during or after welding, shall be rapped with a 500 g hammer during the pressure decrease or treated other wise to obtain the required effect of stress relief.

31.8.9 Finally, the test pressure mentioned above shall be maintained for ten (10) minutes. Leakages appearing at seals, joints, etc. shall be measured and stated in the test report, together with the relevant pressures.

II) Parts Exposed to Liquids without Over-Pressure

31.8.10 Parts which shall not be closed and which are exposed to only small pressures of any liquid during operation e.g. bearing housings, oil containers, etc. shall be subjected to a tightness test with a suitable liquid of low viscosity. The testing-period shall not be less than 10 hours, unless otherwise agreed.

31.9 Functional Tests

31.9.1 Functional tests shall be defined as tests of the function of assemblies, subassemblies or parts of the plant under no load conditions. Functional tests shall be performed on all plant prior to the execution of operational tests.

31.9.2 Operational Tests

As far as practicable operational test shall be carried out on all plant, simulating operating conditions.

31.9.2.1 Parts to be delivered by sub-suppliers shall be tested either at the premises of the sub-supplier or of the Contractor, as agreed by the Purchaser.

31.9.2.2 Before testing the Contractor shall submit a notice containing full information on the tests with detailed tables or graphs on the latest edition of the characteristic values of the plant to be tested and on the test facilities and equipment.

31.9.2,3 Testing of the electrical plant shall be performed in accordance with applicable Standards; they shall include but not be limited to tests for heating, loading, overloading, losses.

31.9.2.4 Operational tests of lifting equipment and other machinery shall include tests under nominal load and 125% of nominal load unless otherwise specified.

31.9.3 Model Tests

Model tests for certain parts of the work or plant shall be carried out as specified.

31.9.4 Test Reports

Contractor shall have to furnish all the test reports of tests performed on materials, equipments & plants etc. during various stages such as manufacturing, shop assembly etc.

31.9.5 Site Inspection and Tests

31.9.5.1 During erection, commissioning and Test Service Period operation the Contractor shall perform at suitable interval all inspections and tests in the presence of the Purchaser in order to prove the orderly execution of the works in accordance with the Contract.

31.9.5.2 Unless otherwise specified, all costs for testing at Site and of the works and charges associated with it shall be born by the Contractor. This includes the measuring devices, properly calibrated, and any pertinent accessories, which shall be made available by the Contractor for the entire duration of the tests. The Contractor shall delegate his experts to perform the tests at site.

31.9.5.3 For the procedure of inspections and test at Site, notice to the Purchaser, reports, commissioning trial runs and acceptance tests refer to General Conditions.

32 PRE-COMMISSIONING AND COMMISSIONING FACILITIES

32.1 As soon as the facilities or part thereof has been completed operationally and structurally and before start-up, each item of the equipment and systems forming part of facilities shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness of and completeness of facility or part thereof and acceptability for initial pre-commissioning tests, commissioning and start-up at Site. The list of pre-commissioning tests to be performed shall be as mutually agreed and included in the Contractor's quality assurance programme as well as those included elsewhere in the Technical Specifications.

32.2 The Contractor's pre-commissioning/ commissioning/start-up engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests at Site. On completion of inspection, checking and after the pre-commissioning tests are satisfactorily over, the commissioning of the complete facilities shall be commenced during which period the complete facilities, equipments shall be operated integral with sub-systems and supporting equipment as a complete plant.

32.3 The time consumed in the inspection and checking of the units shall be considered as a part of the erection and installation period.

32.4 The check outs during the pre - commissioning period should be programmed to follow the construction completion schedule. Each equipment/system, as it is completed in construction and

turned over to Employer's commissioning (start-up) Engineer(s), should be checked out and cleaned. The checking and inspection of individual systems should then follow a prescribed schedule to be agreed by Employer.

32.5 The Contractor during initial operation and performance testing shall conduct vibration testing to determine the 'base line' of performance of all plant rotating equipment. These tests shall be conducted when the equipment is running at the base load, peak load as well as lowest sustained operating condition as far as practicable.

32.6 Contractor shall furnish the commissioning organisation chart for review & acceptance of employer at least eighteen months prior to the schedule date of synchronisation.

32.7 Initial Operation

32.7.1 Subsequent to completion of all pre-commissioning activities/ tests and as a part of commissioning the complete facilities shall be put on 'Initial Operation' during which period all necessary adjustments shall be made while operating over the full load range enabling the facilities to be made ready for the Guarantee Tests.

32.7.2 The 'Initial Operation' of the complete facility as an integral unit shall be conducted for 720 continuous hours. During the period of initial operation of 720 hours, the unit shall operate continuously at full rated load for a period not less than 72 hours.

32.7.3 The Initial Operation shall be considered successful, provided that each item/ part of the facility can operate continuously at the specified operating characteristics, for the period of Initial Operation with all operating parameters within the specified limits and at or near the predicted performance of the equipment/ facility.

32.7.4 The Contractor shall intimate the Employer about the commencement of initial operation and shall furnish adequate notice to the Employer in this respect.

32.7.5 Any loss of generation due to constraints attributable to the Employer shall be construed as Deemed Generation.

32.7.6 An Initial Operation report comprising of observations and recordings of various parameters to be measured in respect of the above Initial Operation shall be prepared by the Contractor. This report, besides recording the details of the various observations during initial operation shall also include the dates of start and finish of the Initial Operation and shall be signed by the representatives of both the parties. The report shall have sheets, recording all the details of interruptions occurred, adjustments made and any minor repairs done during the Initial Operation. Based on the observations, necessary modifications/repairs to the plant shall be carried out by the Contractor to the full satisfaction of the Employer to enable the latter to accord permission to carry out the Guarantee tests on the facilities. However, minor defects

which do not endanger the safe operation of the equipment, shall not be considered as reasons for with- holding the aforesaid permission.

32.8 Guarantee Tests

32.8.1 The final test as to prove the Guarantees shall be conducted at Site by the Contractor in presence of the Employer. The contractor's Commissioning, start-up and initial operation shall make the unit ready to conduct such test.

32.8.2 These tests shall be binding on both the parties of the Contract to determine compliance of the equipment with the performance guarantees.

32.8.3 For performance/ demonstration tests instrumentations, of accuracy class, to the approval of the Employer shall be used. The numbers and location of the instruments shall be as per the specified test codes.

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

32.8.5 The Guarantee tests and specific tests to be conducted on equipments have been brought out in detail in the technical specification of each equipment.

33 Taking Over

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

34 DEPUTATION OF EMPLOYER'S ENGINEERS FOR INSPECTION, WITNESSING OF TESTS AND TRAINING FOR THE EQUIPMENT SUPPLIED FROM ABROAD.

34.1 Purchaser will depute a team of its own engineers & consultants for Inspection, witnessing of tests, training of various important components of the equipment supplied from abroad.

TRAINING

i) Planning, Design and Engineering (Transfer of Knowledge)

The Contractor shall arrange to provide on the job training on various aspects of Design, Analysis, construction, manufacture

etc. for Employer's personnel up to 60 Man-months (30 Man-months for Electro-mechanical and 30 Man-months for Civil).

The Training courses for all disciplines (Civil, Electro-mechanical & HM) shall be organized in the countries of the manufacturers of Electromechanical equipments and also where similar plants are under operation.
This training shall include but not limited to on the job training in planning, designing, computation analysis of stability and structural strength of various underground structures, analysis for Surges / Transients; Design, Analysis of EM and HM equipments viz. Turbine/Pump, Governor, Spherical Valve, Butterfly Valve, Generator/Motor, Excitation System, Generator Transformer, CCS and SCADA, Protection System etc., Construction Management, Model Testing, pressure testing, nondestructive and destructive testing, visits to the laboratories of the research centres as well as similar Projects and Operational Installations.

The Contractor shall provide at his own cost to the Employer's personnel internal transportation, office rooms, interpreter services, assistance in arranging accommodation but excluding any subsistence allowance.

The program for training the Employer's personnel shall be subject to mutual agreement between the Employer and the Contractor within a three-month period of Effective date of the Contract or date of start. The contractor shall submit in due time to the Employer for approval the programme for training the Employer's personnel.

The programme for training the Employer's personnel shall be corrected or modified on agreement between the Employer and the Contractor.

ii). Operation and Maintenance:

The contractor shall arrange to provide training on operation & Maintenance for Employer Personnel for 32 (thirty two) man-months on E/M Equipments viz. Turbine / Pump, Governor, Spherical Valve, Butterfly valve, Generator / Motor, Excitation System, Generator Transformer, CCS &SCADA and Protection system. Breakup of Equipment wise training and batches to be given by the Bidder limited to training for 32 (Thirty Two) man - months in all, matching with the recommended Organization Chart and elaborate plan for training of Employer's Personnel on Operation and Maintenance of the Station subsequent to Commissioning.

The Contractor shall provide at his own cost to the Employer's personnel internal transportation, office rooms, interpreter services, assistance in arranging accommodation but excluding any subsistence allowance.

35 TRAINING OF EMPLOYER'S PERSONNEL

35.1 In addition to the requirements given in Section General Condition of contract (GCC), regarding training of Employer's personnel, the following shall also apply.

35.2 The Contractor shall provide suitable instructors, training material and facilities (instruments, apparatus, simulators, documents, drawings, protective clothing, rooms, office supplies, etc.) for the Personnel made available by the Employer for training.

35.3 One month before the training start, the Employer will send the list of the trainees and any comments on the training program proposed by the Contractor. This program shall be adapted to the design and nature of the Works, and the needs of trainees. Trainees shall be suitably trained in the various aspects of design, manufacture, installation/erection, operation and maintenance, relevant to the training, of works similar to the Works

35.4 The Contractor shall supervise and provide direction to, and be liable for the acts or omissions, other than negligent or wilful misconduct of such personnel, of the Employer's trainees.

35.5 The Contractor shall provide the training described hereafter in accordance with any further specific requirements stated in the Employer's Requirements.

35.6 The Contractor shall assist the Employer in obtaining any visas and other formalities for entering or leaving the territory on which the training is being provided.

35.7 The Contractor shall bear responsibility for ensuring the safety of the trainees during their stay in the country of the training. On their part, the trainees shall comply with the laws, regulations and customs of the country in which training is being held.

35.8 In the event of illness or accident, the Contractor shall take all steps to provide the trainees with the appropriate medical care.

35.9 The Bidder shall provide training to Employer's personnel to meet operational and maintenance requirements of various Systems/equipments supplied under this package.

35.10 The scope of service under training of Employer's engineers shall include a training module covering the following :

35.11 Training During Engineering/ Manufacturing Phase

35.11.1 This shall cover all disciplines viz, Mechanical, Electrical, C&I & QA etc. and shall include all the related areas like Design familiarisation, training on product design features and product design software of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, plant visits and visits to manufacturer's works, exposure to various kinds of problems which may be encountered in fabrication, manufacturing, erection, welding etc. The training in areas of

Operation and Maintenance shall take place preferably during end of manufacture/ tests.

35.12 Training During the Erection / Installation / Site Work

35.12.1 Independently from the supervision and inspection functions of the Employer's Representative, the Contractor shall authorise the Employer's Personnel to follow the erection / installation / site work at his site.

35.12.2 The Employer's Start-up Personnel shall take no part in the equipment erection and/or installation operations, which shall be exclusively carried out by the Contractor and under his entire responsibility.

35.12.3 This on site training shall cover each phase of erection / installation / site work and shall be of sufficient duration.

35.12.4 The Contractor shall supply the information or measurements concerning the erection requested by the Employer's Representative or/and by the Employer's personnel.

35.13 Training during the Tests on Completion phase, Operation & Maintenance

35.13.1 The scope of service under training of Customer's engineers shall necessarily include, training of upto twelve (12) Employer's personnel for the power plant in the areas of Operation & Maintenance The Contractor shall provide on the-job training in the operation and maintenance of the Works to the Employer's Operating Personnel. Such training shall start at least 30 days prior to commencement of Tests on Completion and continue until Taking Over. Its scope and quality shall be such so that the operation and maintenance phase of the project can be carried out to ensure sustained guaranteed performance of the equal availability of the units as offered. The training should provide the trainees with comprehensive understanding of all operational and maintenance aspects of the Works. Such training shall also include safety and environmental protection aspects applicable to the Works.

35.13.2 Exact details, extent of training and the training schedule shall be finalised based on the Bidder's proposal.

35.13.3 In all the above cases, whenever the training of Employer's personnel is arranged at the works of the manufacturers, it shall be noted that the lodging and boarding of the Employer's personnel shall be Bidder's scope. The Bidder shall make all necessary arrangements towards the same.

36 SYSTEM DOCUMENTATION

36.1 The Bidder shall provide drawings, system overview & description, hardware/ software details, technical literature, functional & hardware schemes, bill of material, parts list, interconnection diagrams, data sheets, erection/ installation/

commissioning procedures, instruction/ operating manuals, etc. for each system / sub-systems/ equipment supplied under this package. The documentation shall include complete details of the systems/ sub-systems/ equipment to enable review by Employer during detailed engineering stage and to provide information to plant personnel for operation & Maintenance (including quick diagnostics & trouble shooting) of these systems/ sub-systems/ equipment at site.

36.2 The exact format, submission schedule and contents of various documents shall be as finalised during detailed engineering stage.

37 REGULATION OF LOCAL AUTHORITIES AND STATUTES

37.1 In addition to the local laws and regulations the Contractor shall also comply with the Minimum Wages Act and the Payment of Wages Act (both of the Government of India) and the rules made there under in respect of its labour and the labour of its sub-contractors currently employed on or connected with the contract.

37.2 All registration and statutory inspection fees, if any, in respect of his work pursuant to this Contract shall be to the account of the Contractor. However, any registration, statutory inspection fees lawfully payable under the provisions of the Indian Boiler Regulations and any other statutory laws and its amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Employer, shall be to the account of the Employer. Should any such inspection or registration need to be re-arranged due to the fault of the Contractor or his Sub-Contractor, the additional fees to such inspection and/or registration shall be borne by the Contractor.

38 ACCESS TO SITE AND WORKS ON SITE

38.1 Suitable access to site and possession of the Site shall be afforded to the Contractor by the Employer in reasonable time.

38.2 In the execution of the Works, no person other than the Contractor or his duly appointed representative, Sub-Contractor and workmen, shall be allowed to do work on the Site, except by the special permission, in writing by the Employer or his representative.

39 CONTRACTOR'S SITE OFFICE ESTABLISHMENT

The Contractor shall establish a Office at the Site and keep posted an authorised representative for the purpose of the Contract. Any written order or instruction of the Employer or his duly authorised representative shall be communicated to the said authorised resident representative of the Contractor and the same shall be deemed to have been communicated to the Contractor at his legal address.

40 CO-OPERATION WITH OTHER CONTRACTORS

40.1 The Contractor shall co-operate with all other Contractors or tradesmen of the Employer, who may be performing other works on behalf of the Employer and the workmen who may be employed by the Employer and doing work in the vicinity of the Works under the Contract. The Contractor shall also arrange to perform his work as to minimise, to the maximum extent possible, interference with the work of other Contracts and their workmen. Any injury or damage that may be sustained by the employees of the other Contractors and the Employer, due to the Contractor's work shall promptly be made good at his own expense. The Employer shall determine the resolution of any difference or conflict that may arise between the Contractor and other Contractors or between the Contractor and the workmen of the Employer in regard to their work. If the work of the Contractor is delayed because of the any acts of omission of another Contractor, the Contractor shall have no claim against the Employer on that account other than an extension of time for completing his Works.

40.2 Employer shall give full access to visit the contractor's site at any time for inspection & surveillance checks.

40.3 The Employer shall be notified promptly by the Contractor of any defects in the other Contractor's works that could affect the Contractor's Works. The Employer shall determine the corrective measures if any, required to rectify this situation after inspection of the works and such decisions by the Employer shall be binding on the Contractor.

41 DISCIPLINE OF WORKMEN

The Contractor shall adhere to the disciplinary procedure set by the Employer in respect of his employees and workmen at Site. The Employer shall be at liberty to object to the presence of any representative of employee of the Contractor at the Site, if in the opinion of the Employer such employee has mis-conducted himself or incompetent or negligent or otherwise undesirable then the Contractor shall remove such a person objected to and provide in his place a competent replacement.

42 CONTRACTOR'S FIELD OPERATION

42.1 The Contractor shall keep the Employer informed in advance regarding his field activity plans and schedules for carrying out each part of the works. Any review of such plan or schedule or method of work by the Employer shall not relieve the Contractor of any of responsibilities towards the field activities. Such reviews shall also not be considered as an assumption of any risk or liability by the or the Employer or any of his representatives and no claim of the Contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method of work reviewed. The Contractor shall be solely responsible for the safety, adequacy and efficiency of plant and equipment and his erection methods.

42.2 The Contractor shall have the complete responsibility for the

conditions of the Work-Site including the safety of all person employed by him or his Sub-Contractor and all the properties under his custody during the performance of the work. This requirement shall apply continuously till the completion of the Contract and shall not be limited to normal working hours. The construction review by the Employer is not intended to include review of Contractor's safety measures in, on or near the Work-Site, and their adequacy or otherwise.

43 PROTECTION OF WORK

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the Employer. No claim will be entertained by the Employer or the Employer for any damage or loss to the Contractor's works and the Contractor shall be responsible for complete restoration of the damaged works to original conditions to comply with the specification and drawings. Should any such damage to the Contractor's Works occur because or other party not being under his supervision or control, the Contractor shall make his claim directly with the party concerned. If disagreement or conflict or dispute develops between the Contractor and the other party or parties concerned regarding the responsibility for damage to the Contractor's Works the same shall be resolved as per the provisions contract document. The Contractor shall not cause any delay in the repair of such damaged Works because of any delay in the resolution of such disputes. The Contractor shall proceed to repair the Work immediately and no cause thereof will be assigned pending resolution of such disputes.

44 EMPLOYMENT OF LABOUR

44.1 In addition to all local laws and regulations pertaining to the employment of labour to be complied by the Contractor pursuant to GCC, the Contractor will be expected to employ on the work only his regular skilled employees with experience of his particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

44.2 All travelling expenses including provisions of all necessary transport to and from Site, lodging allowances and other payments to the Contractor's employees shall be the sole responsibility of the Contractor.

44.3 The hours of work on the Site shall be decided by the Employer and the Contractor shall adhere to it.

44.4 Contractor's employees shall wear identification badges while on work at Site.

44.5 In case the Employer becomes liable to pay any wages or dues to the labour or any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contact Labour Regulation Abolition Act or any other law due to act of omission of the Contractor, the Employer may make such

payments and shall recover the same from the Contractor's Bills.

45 FACILITIES TO BE PROVIDED BY THE EMPLOYER

45.1 Space

The Contractor shall advise the Employer within thirty (30) days from the date of acceptance of the Notification of Award about his exact requirement of space for his office, storage area, pre-assembly and fabrication areas, labour and staff colony area, toilets, etc. The above requirement shall be reviewed by the Employer and space as decided by Employer will be allotted to the Contractor for construction of his temporary structures/ facilities like office, storage sheds, pre-assembly and fabrication areas labour and staff colony, toilets, etc. for Contractor's as well as his Sub-Contractor's use.

45.2 Electricity

The Contractor shall submit to the Employer within thirty (30) days from the date of acceptance of the Notification of Award, his electrical power requirements, if any, to allow the planning of the same by the Employer. The supply of electric power for the main works of construction and domestic purpose will be provided by owner at minimum 2 points (one each at work site & colony) at 11kV, 3 phase 50 c/s . The charges for this purposes will be at the prevailing rate of state electricity utility. The Contractor shall make his own further distribution arrangement. All temporary wiring must comply with local regulations and will be subject to Employer inspection and approval before connection to supply.

45.3 Water

Contractor shall make all arrangements himself for the supply of construction water as well as potable water for labour and other personnel at the worksite /colony.

45.4 Communication :

The employer will extend the telephone facilities, if available at site, for purpose of contract. The Contractor shall be charged at actuals for such facilities.

46 FACILITIES TO BE PROVIDED BY THE CONTRACTOR

46.1 Contractor's site office Establishment

The Contractor shall establish a site office at the site and keep posted an authorized representative for the purpose of the contract, pursuant to GCC.

46.2 Tools, tackles and scaffoldings

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, erection, testing and commissioning of the equipments covered under the Contract. He shall submit a list of all such materials to the Employer before the commencement of pre-assembly at Site.

These tools and tackles shall not be removed from the Site without the written permission of the Employer. The Contractor shall arrange Dozer, Hydra, Cranes, Trailor, etc. for the purpose of fabrication, erection and commissioning.

46.3 First-aid

50.4.46 The Contractor shall provide necessary first-aid facilities for all his employees, representatives and workmen working at the Site. Enough number of Contractor's personnel shall be trained in administering first-aid.

50.4.47 The Employer will provide the Contractor, in case of any emergency, the services of an ambulance for transportation to the nearest hospital.

46.4 Cleanliness

46.4.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris etc. during the period of Contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the Employer. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of a flame resistant, oil proof sheet shall be provided to protect the floor from such damage.

46.4.2 Similarly the labour colony, the offices and the residential areas of the Contractor's employees and workmen shall be kept clean and neat to the entire satisfaction of the Employer. Proper sanitary arrangements shall be provided by the Contractor, in the work-areas, office and residential areas of the Contractor.

47 CONSTRUCTION MANAGEMENT

47.1 The field activities of the Contractors working at Site, will be coordinated by the Employer and the Employer decision shall be final in resolving any disputes or conflicts between the Contractor and other Contractors and tradesmen of the Employer regarding scheduling and co- ordination of work. Such decision by the Employer shall not be a cause for extra compensation or extension of time for the Contractor.

47.2 The Employer shall hold weekly meetings of all the Contractors working at Site, at a time and place to be designated by the Employer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Employer and shall strictly adhere to those decisions in performing his Works. In addition to the above weekly meeting, the Employer may call for other meeting either with individual Contractors or with selected number of Contractors and in such a case the Contractor if called, will also attend such meetings.

47.3 Time is the essence of the Contract and the Contractor shall be

responsible for performance of his works in accordance with the specified construction schedule. If at any time, the Contractor is falling behind the schedule, he shall take necessary action to make good for such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the Employer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

47.4 The Employer shall however not be responsible for provision of additional labour and/or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

48 FIELD OFFICE RECORDS

The Contractor shall maintain at his Site Office up-to-date copies of all drawings, specifications and other Contract Documents and any other supplementary data complete with all the latest revisions thereto. The Contractor shall also maintain in addition the continuous record of all changes to the above Contract Documents, drawings, specifications, supplementary data, etc. effected at the field and on completion of his total assignment under the Contract shall incorporate all such changes on the drawings and other Engineering data to indicate as installed conditions of the equipment furnished and erected under the Contract. Such drawings and Engineering data shall be submitted to the Employer in required number of copies.

49 PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY

49.1 The Contractor shall be responsible for any damage resulting from his operations. He shall also be responsible for protection of all persons including members of public and employees of the Employer and the employees of other Contractors and Sub-Contractors and all public and private property including structures, building, other plants and equipments and utilities either above or below the ground.

49.2 The Contractor will ensure provision of necessary safety equipment such as barriers, sign-boards, warning lights and alarms, etc. to provide adequate protection to persons and property. The Contractor shall be responsible to give reasonable notice to the Employer and the Employers of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his Works and shall make all necessary arrangements with such Employers, related to removal and/or replacement or protection of such property and utilities.

50 INSURANCE FOR CONTRACTOR'S EMPLOYER AT SITE

50.1 In addition to the conditions covered under the Clause entitled "Insurance" in Section General Conditions of Contract (GCC), the following provisions will also apply to the portion of works to be

done beyond the Contractor's own or his Sub-Contractor's manufacturing Works.

50.2 Workmen's Compensation Insurance

This insurance shall protect the Contractor against all claims applicable under the Workmen's Compensation Act, 1948 (Government of India). This policy shall also cover the Contractor against claims for injury, disability disease or death of his or his Sub-Contractor's employees, which for any reason are not covered under the Workmen's Compensation Act, 1948. The liabilities shall not be less than Workmen's Compensation As per statutory Provisions Employee's liability.

50.3 Comprehensive Automobile Insurance

This insurance shall be in such a form to protect the Contractor against all claims for injuries, disability, disease and death to members of public including the Employer's men and damage to the property of other arising from the use of motor vehicles during on or off the Site operations, irrespective of the Ownership of such vehicles. The liability covered shall be as herein indicated :

Fatal Injury	:	Rs.100,000 each person
	:	Rs.200,000 each occurrence
Property Damage	:	Rs.100,000 each occurrence

50.4 Comprehensive General Liability Insurance

50.4.1 The insurance shall protect the Contractor against all claims arising from injuries, disabilities, disease or death of members of public or damage to property of others, due to any act or omission on the part of the Contractor, his agents, his employees, his representatives and Sub-Contractors or from riots, strikes and civil commotion. This insurance shall also cover all the liabilities of the Contractor arising out of the Clause entitled "Defence of Suits" in Section General Conditions of Contract (GCC).

50.4.2 The hazards to be covered will pertain to all the Works and areas where the Contractor, his Sub-Contractors, his agents and his employees have to perform work pursuant to the Contract.

50.4.3 The above are only illustrative list of insurance covers normally required and it will be the responsibility of the Contractor to maintain all necessary insurance coverage to the extent both in time and amount to take care of all his liabilities either direct or indirect, in pursuance of the Contract.

ANNEXURE-I

NUMBER OF COPIES OF DRAWING AND DOCUMENTS

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
1.	PLANT DEFINITION MANUAL	-	3 CD-ROMs	10
2.	Drawings "FOR APPROVAL"	4	1 CD-ROM or Soft Copies by E-Mail	-
3.	Drawings "FOR INFORMATION"	4	1 CD-ROM or Soft Copies by E-Mail	-
4.	Drawings "FINAL DRAWING"	10	3 CD-ROMs	-
5.	Drawings "AS BUILT"	10	3 CD-ROMs	-
6.	DATA SHEETS, DESIGN CALCULATIONS, PURCHASE SPECIFICATIONS, etc. and Other type of documents.			
	i) For Approval	4	3 CD-ROMs/Soft Copies by E-Mail	-
	ii) FINAL	10	3 CD-ROMs	-
	iii) Analysis reports of equipments / structures components / systems employing software packages as detailed in the specifications			
	a) Input	4	3CD-ROMs	-
	b) Output	4	3CD-ROMs	-

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
	c) Drawings / Sketches	4	3CD-ROMs	-
7.	Erection manual "DRAFT"	-	1 CD-ROM or Soft Copies by E-Mail	4
8.	Erection manual "FINAL"	-	3CD-ROMs	10
9.	Operation & Maintenance manual "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
10.	Operation & Maintenance manual "FINAL"	-	3CD-ROMs	10
11.	Plant Hand Book "DRAFT"	1	1 CD-ROM or Soft Copies by E-Mail	4
12.	Plant Hand Book "FINAL"	3	3 CD-ROMs	10
13.	Commissioning and Performance Procedure manual "DRAFT"	1	3 CD-ROMs/ Soft Copies by E-Mail	4
14.	Commissioning and Performance Procedure manual "FINAL"	1	3 CD-ROMs	10
15.	Performance and Functional Guarantees test report	8	3 CD-ROMs	
16.	Progress Reports	8	3 CD-ROMs/ Soft Copies by E-Mail	
17.	Project completion report	15	3 CD-ROMs	-
18.	QA programme including Organisation for implementation and QA system manual (with revision servicing)	15	3 CD-ROMs	-

Sl. No.	DESCRIPTION	NO. OF PRINTS	NO. OF CD-ROMs (SETS)	NO. OF MANUALS (SETS)
19.	Vendor details in respect of proposed vendors, including Contractor's evaluation report.	1	-	-
20.	Manufacturing QP's, Field QPs, Field welding schedules and their reference documents like test procedures, WPS, POR etc.			
	i) For review / comment	3	-	-
	ii) For final approval	4	1 CD-ROM 1	
21.	Welding Manual, Heat Treatment Manuals, Storage & preservation manuals			
	i) Draft	-	-	4 sets
	ii) Final	-	2 CD-ROMs	4 sets
22.	Monthly Vendor Approval and QP approval status	2	1 CD-ROM or Soft Copies by E-Mail	
23.	QA Documentation package for items / equipment manufactured and despatched to site.	2	2 CD-ROMs	
24.	QA Documentation Package for field activities on equipment / system at site.	2	2 CD-ROMs	

THDC India Limited

(A joint venture of Govt. of India and Govt. of UP)

VISHNUGAD-PIPALKOTI H.E. PROJECT
(4x111 MW)

SECTION-29

QUALITY ASSURANCE & INSPECTION REQUIREMENTS

FOR

ELECTRO-MECHANICAL WORKS

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QA&I: Vishnugad-Pipalkoti HEP (4x111 MW)

General

VISHNUGAD-PIPALKOTI HEP (4x111 MW)

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1.0 DEFINITIONS/ VOCABULARY

Accept-as-it-is: A disposition which may be imposed for non- conformance when it can be established that the discrepancy will result in no adverse conditions and that the item under- consideration will continue to meet all engineering functional requirements including performance, maintainability, fitness to use and safety.

Assessment : An appraisal to evaluate the Contractor/Sub-Contractor's manufacturing, testing and quality management systems to ensure that:

(a) Contractor/Subcontractor is capable of manufacturing the product as per specific requirement.

(b) Contractor/Subcontractor is reliable in terms of consistency of quality.

Calibration: A comparison between a measuring instrument or equipment with a standard/ higher accuracy instrument/ equipment to detect, correlate, adjust the accuracy of the measuring instrument or equipment being compared or tested.

C.H.P.: CHP "Customer Hold Point" is a stage identified by customer in Quality Plan, which is to be offered to customer or its authorised representative for witnessing, verification or review, beyond which work will not proceed without written consent of the Inspecting Authority.

Corrective action:

Action taken to eliminate the cause of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. The corrective actions may involve changes, such as procedures and systems, to achieve quality improvement at any stage of the quality loop.

There is a distinction between "correction" and "corrective action".

"Correction" refers to repair, rework or adjustment and relates to the disposition of an existing nonconformity.

"Corrective action" relates to the elimination of the causes of nonconformity.

Data Book - Manufacturer's data book provides the record of observations clearances, test results, material certificates etc. of equipment during the manufacture.

Despatch Schedule - A document mutually agreed between purchaser and equipment supplies for the sequential and timely despatch of materials required at site.

Disposition of Nonconformity

Action to be taken to deal with an existing nonconforming entity in order to resolve the nonconformity.

The action may be in form of, for example, correction such as repair or rework, regrade, scrap, concession and amendment of a document or a requirement.

Disposition - Instructions for acceptance of re-work or rejection of non-conformities.

Equipment - An assembly of components which can perform independent function shall be called 'Equipment' .

Field welding schedule sheet - The form used to document field weld locations, numbers, welding procedure to be used, requirements, code and NDE requirements for a specific contract.

Inspection -The process of measuring, examining, testing gauging or otherwise comparing one or more characteristics of the product or service with the specified requirements.

Major Non-conformances : Major non-conformances are those which have a direct or indirect adverse effect on performance, reliability, safety, interchangeability, maintainability, working life or on site activities of the material, equipment or service.

MDCC – MDCC "Material Dispatch Clearance Certificate" issued by Employer's Engineer-in-Charge/ Authorized representative authorizing dispatch of items after satisfactory completion of all tests/checks.

Minor Non-conformances – All other Non-Conformances not covered in "Major Non-Conformances" shall be considered "Minor Non-conformity".

Measuring equipment – All devices used to measure, gauge test, inspect or otherwise quantify the characteristics of an article.

N.D.E. - Non-destructive examination includes, but not limited to, radiographic examination, magnetic particle examination, ultrasonic examination, liquid, penetrant examination and steeloscopic examination.

Non-conforming items - A deficiency in characteristics, documentations on procedure which renders the quality of an item unacceptable or in determinate.

Non-Conformity – Non fulfillment of a specified requirement – The definition covers the departure or absence of one or more quality characteristics (including dependability characteristics) or quality system elements from specified requirements.

Non-Conformity Dispositioning Request: Non-Conformity Dispositioning Requests are formal requests from Contractors/ suppliers to deviate from a specified quality requirement, Nonconformities are to be detected and reported as soon as possible.

Process - Procedure or techniques followed in the production or erection of a product.

Pre-commissioning- All activities pertaining to individual starting and trial run of individual equipment or upto first rolling of turbo-set, whichever is later .

Plant - A combination of equipment working together to perform one single function shall be called plant.

Quality - The totality of features and characteristics (attributes) of a product or service that qualifies it to satisfy a given need.

Quality Audit: An activity to determine through investigation the adequacy of an adherence to established procedures, instructions, specifications, code and standards and other contractual requirements and the effectiveness of implementation.

Quality Assurance - All those planned and systematic actions necessary to provide adequate confidence that an item, equipment or a system will perform satisfactorily in service.

Quality Control: Actions stipulated on quality assurance plan which provide a mean to control and measure the characteristics of an item, process of facility to established requirements.

Quality Plan - A document setting out the specific quality practices and procedures relevant to a particular component, part or a material.

Quality Programme – Overall management and procedures for the execution of a specific contract or project.

Quality Manual – A document specifying the general quality policies and practices of an organisation.

Record: A document which furnishes objective evidence of activities performed or results achieved.

Reliability – The probability of a device, system or facility performing satisfactorily for a specified time under stated operating conditions.

Repair – Action taken on non-conforming product so that it will fulfill the intended usage requirements although it may not conform to the originally specified requirements.

Rework – Action taken on a nonconforming product so that it will fulfill the specified requirements.

Standard – An instrument, device or material of known characteristics and higher precision used to establish and maintain the accuracy of a measurement system or device.

Verification – An act of conforming, substantiating and assuring that an activity or condition has been implemented in conformance with the specified requirements.

Welding Procedure Qualification Record – A WPQR is a record of Welding data used to weld a test coupon. The WPQR is a record of variables recorded during the welding of test coupons. It also contains the test results of the tested specimen. Recorded variables normally fall within a small range of the actual variables that will be used the production welding.

Welding Procedure Specification – A form giving the details of welding procedures such as base material, filler materials, range of preheat and post weld heat treatment temperature, thickness etc.

2.0 A: GENERAL TECHNICAL REQUIREMENTS

1.00.00 INTRODUCTION

This part covers general technical requirements which will form an integral part of the Contract. The following provisions shall supplement all the detailed technical specifications and requirements brought out in the technical Specification and the Technical Data Sheets.

2.00.00 QUALITY ASSURANCE PROGRAMME

2.01.01 THDC has adopted a Model Quality Management System Manual available at THDC website www.thdc.gov.in. The Contractor shall prepare a suitable **Project Quality Management Plan (PQMP)** - a quality assurance programme based on THDC's Model Quality Management System Manual and shall submit the same for client's approval to ensure that the equipment and services under the scope of contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Employer's site or at any other place of work are in accordance with the specifications. Such PQMP shall be outlined by the Contractor and shall be finally accepted by the Employer/authorised representative after discussions before award of the contract. The QA programme shall be generally in line with IS/ISO-9001/other international standards. A Quality Assurance programme of the contractor shall generally cover the following:

i. His organization structure for the management and implementation of the proposed quality assurance programme
ii. Quality System Manual
iii. Design Control System
iv. Documentation and Data Control System
v. Qualification data for Bidder's key Personnel.
vi. QA Co-ordination Procedure of Contractor for his in-house and sub-supplier's manufacturing and field activities.
vii. The procedure for purchase of materials, parts, components and selection of sub-contractor's services including vendor analysis,

source inspection, incoming raw-material inspection, verification of materials purchased etc.

viii. System for shop manufacturing and site erection controls including process, fabrication and assembly.

ix. Control of non-conforming items and system for corrective actions and resolution of deviations.

x. Inspection and test procedure both for manufacture and field activities.

xi. Control of calibration and testing of measuring testing equipments.

xii. System for Quality Audits.

xiii. System for identification and appraisal of inspection status.

xiv. System for authorising release of manufactured product to the Employer.

xv. System for handling, storage and delivery.

xvi. System for maintenance of records, and

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

2.01.02 QA CO-ORDINATION PROCEDURE

A QA Co-ordination Procedure shall be adopted by all parties to the Contract for smooth functioning of QA&I activities as annexed at Annexure-CP.

2.02.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

2.02.01 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the contractor for some of the major items is given in the respective technical specification. This is, however, not intended to form a comprehensive programme as it is the contractor's responsibility to draw up and implement such programme duly approved by the Employer. The detailed Quality Plans for manufacturing and field activities shall be drawn up by the Bidder and will be submitted to

Employer for approval. Schedule of finalisation of such quality plans will be finalised before award.

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

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

2.02.04 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality Plans and reference documents/standards etc. will be subject to Employer's approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved Quality Plans, Employer shall identify customer hold points (CHP), i.e. test/checks which shall be carried out in presence of the Employer's Engineer-in-charge or his authorised representative and beyond which the work will not proceed without consent of Employer in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Employer along with technical justification for approval and dispositioning.

2.02.05 No material shall be despatched from the manufacturer's works before the same is accepted, subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Employer's Engineer-in-charge/Authorised representative and duly

authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC).

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

2.02.07 The contractor shall submit to the Employer Field Welding Schedule for field welding activities The field welding schedule shall be submitted to the Employer along with all supporting documents, like welding procedures, heat treatment procedures, NDT procedures etc. at least, unless otherwise specified in Employer's Requirement, ninety days before schedule start of erection work at site.

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

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

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

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

2.02.11 Any other statutory requirements as applicable for the equipments/systems shall also be complied with.

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

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

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

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

All plates of thickness above 40mm & all bar stock/Forging above 40mm dia shall be ultrasonically tested. For pressure parts, plate of thickness equal to or above 25mm shall be ultrasonically tested.

2.02.16 The Contractor shall list out all major items/ equipments/ components to be manufactured in house as well as procured from sub-contractors (BOI). All the sub-contractor proposed by the Contractor for procurement of major bought out items including castings, forging, semi-finished and finished components/equipment etc., list of which shall be drawn up by the Contractor and finalised with the Employer, shall be subject to Employer's approval. The contractor's proposal shall include vendor's facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-contractors enclosed and shall be submitted to the Employer for approval within the period agreed at the time of pre-awards discussion and identified in "DR" category prior to any procurement. Monthly progress report on sub-contractor details submission / approval shall be furnished. Such vendor approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

2.02.17 For components/equipment procured by the contractors for the purpose of the contract, after obtaining the written approval of the Employer, the contractor's purchase specifications and inquiries shall call for quality plans to be submitted by the suppliers. The quality plans called for from the sub-contractor shall set out, during the various stages of manufacture and installation, the quality practices and procedures followed by the vendor's quality control organisation, the relevant reference documents/standards used, acceptance level, inspection of documentation raised, etc. Such quality plans of the successful vendors shall be finalised with the Employer and such approved Quality Plans shall form a part of the purchase order/contract between the Contractor and sub-contractor. Within three weeks of the release of the purchase orders/contracts for such bought out items/components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the Employer on the monthly basis by the Contractor along with a report of the Purchase Order placed so far for the contract.

2.02.18 Employer reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-contractor's quality management and control activities. The contractor shall provide all necessary assistance to enable the Employer carry out such audit and surveillance.

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

2.02.20 Quality audit/surveillance/approval of the results of the tests and inspection will not, however, prejudice the right of the Employer to reject the equipment if it does not comply with the specification when erected or does not give complete satisfaction in service and the above

shall in no way limit the liabilities and responsibilities of the Contractor in ensuring complete conformance of the materials/equipment supplied to relevant specification, standard, data sheets, drawings, etc.

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

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

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

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

2.03.02 Elevated Temperature Test Cycle

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

During the elevated temperature test the cubicle doors shall be closed (or shall be in the position same as they are supposed to be in the field) and inside temperature in the zone of highest heat dissipating components/modules shall be monitored. The temperature rise inside the cubicle should not exceed 10 deg.C above the ambient temp. at $50^{o}C$.

2.04.00 Burn in Test Cycle

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

During the above tests, the process I/O and other load on the system shall be simulated by simulated inputs and in the case of control

systems, the process which is to be controlled shall also be simulated. Testing of individual components or modules shall not be acceptable.

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

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

2.05.00 QA Documentation Package

The Contractor shall be required to submit the QA Documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark.

2.05.01 Each QA Documentation shall have a project specific Cover Sheet bearing name & identification number of equipment and including an index of its contents with page control on each document.

The QA Documentation file shall be progressively completed by the Supplier's sub- supplier to allow regular reviews by all parties during the manufacturing.

The final quality document will be compiled and issued at the final assembly place of equipment before despatch. However CD Rom may be issued not later than three weeks.

2.05.02 Typical contents of QA Documentation is as below:-

i) Quality Plan

ii) Material mill test reports on components as specified by the specification and approved Quality Plans.

iii) Manufacturer / works test reports/results for testing required as per applicable codes and standard referred in the specification and approved Quality Plans.

iv) Non-destructive examination results /reports/films including radiography/Ultrasonic interpretation reports. Sketches/drawings used for indicating the method of traceability of the radiographs to the location on the equipment.

v) Heat Treatment Certificate/Record (Time- temperature Chart)

vi) All the accepted Non-conformance Reports (Major/Minor) / deviation, including complete technical details / repair procedure).

vii) CHP / Inspection reports duly signed by the Inspector of the Employer and Contractor for the agreed Customer Hold Points.

viii) Certificate of Conformance (COC) wherever applicable.

ix) MDCC

2.05.03 Similarly, the contractor shall be required to submit two sets (two hard copies and two CD ROMs), containing QA Documentation pertaining to field activities as per Approved Field Quality Plans and other agreed manuals/ procedures, prior to commissioning of individual system.

2.05.04 Before despatch / commissioning of any equipment, the Supplier shall make sure that the corresponding quality document or in the case of protracted phased deliveries, the applicable section of the quality document file is completed. The supplier will then notify the Inspector regarding the readiness of the quality document (or applicable section) for review.

i) If the result of the review carried out by the Inspector is satisfactory, the Inspector shall stamp the quality document (or applicable section) for release.

ii) If the quality document is unsatisfactory, the Supplier shall endeavor to correct the incompleteness, thus allowing to finalize the quality document (or applicable section) by time compatible with the requirements as per contract documents. When it is done, the quality document (or applicable section) is stamped by the Inspector.

iii) If a decision is made to despatch, whereas all outstanding actions cannot be readily cleared for the release of the quality document by that time, the supplier shall immediately, upon shipment of the equipment, send a copy of the quality document Review Status signed by the Supplier Representative to the Inspector and notify the committed date for the completion of all outstanding actions & submission. The Inspector shall stamp the quality document for applicable section when it is effectively completed. The submission of QA documentation package shall not be later than 3 weeks after the despatch of equipment.

2.06.00 Transmission of QA Documentation

On release of QA Documentation by Inspector, one set of quality document shall be forwarded to Quality Assurance Department and other set to respective Project Site of Employer.

For the particular case of phased deliveries, the complete quality document to the Employer shall be issued not later than 3 weeks after the date of the last delivery of equipment.

2.07.00 Engineer-in-charge Supervision

2.07.01 To eliminate delays and avoid disputes and litigation, all matters and questions shall be referred to the Engineer-in-charge and without prejudice to the provisions of Arbitration clause in Contract, the Contractor shall proceed to comply with the Engineer-in-charge decision.

2.07.02 The work shall be performed under the supervision of the Engineer-in-charge. The scope of the duties of the Engineer-in-charge pursuant to the Contract will include but not be limited to the following:

i) Interpretation of all the terms and conditions of these documents and specifications:

ii) Review and interpretation of the entire Contractor's drawing, engineering data, etc:

iii) Witness or his authorized representative to witness tests and trials either at the manufacturer's works or at site, or at any place where work is performed under the contract

v) Inspect, accept or reject any equipment, material and work under the contract

vi) Issue certificate of acceptance and/or progressive payment and final payment certificates

vii) Review and suggest modifications and improvement in completion schedules from time to time, and

viii) Supervise Quality Assurance Programme implementation at all stages of the works.

2.08.00 Inspection, Testing and Inspection Certificates

2.08.01 The word 'Inspector' shall mean the Engineer-in-charge and/or his authorised representative and/or an outside inspection agency acting on behalf of the Employer to inspect and examine the materials and workmanship of the works during its manufacture or erection.

2.08.02 The Engineer-in-charge or his duly authorised representative and/or an outside inspection agency acting on behalf of the Employer shall have access at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Engineer-in-charge and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

2.08.03: The Contractor shall give the Engineer-in-charge/ Inspector, unless otherwise specified in Employer's Requirement, **twenty one (21) working days written/electronically advance notice** of any material being ready for testing **alongwith a copy of factory test reports**. The Engineer-in-charge/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within, unless otherwise specified in Employer's Requirement, twenty one (21) working days of the date on which the equipment is noticed as being ready for test/inspection. Such tests shall be to the Contractor's account except for the expenses of the Inspectors.

2.08.04 The Engineer-in-charge or Inspector shall, unless otherwise specified in Employer's Requirement, within twenty one (21) working days from the date of inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings

and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall inform in writing to the Engineer-in-charge/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.

2.08.05 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer-in-charge /Inspector shall issue a certificate to this effect, unless otherwise specified in Employer's Requirement, ten (10) working days after completion of tests but if the tests are not witnessed by the Engineer-in-charge/ Inspectors, the certificate shall be issued, unless otherwise specified in Employer's Requirement, within ten (10) working days of the receipt of the Contractor's test certificate by the Engineer-in-charge /Inspector. Engineer-in-charge /Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificates shall not bind the Employer to accept the equipment should it, on further tests after erection be found not to comply with the contract.

2.08.06 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, material, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Engineer-in-charge /Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contractor and shall give facilities to the Engineer-in-charge/Inspector or to his authorised representative to accomplish testing.

2.08.07 The inspection by Engineer-in-charge / Inspector and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Programme forming a part of the contract.

2.08.08 To facilitate advance planning of inspection in addition to giving inspection notice as above, the Contractor shall furnish quarterly inspection programme indicating schedule dates of inspection at

Customer Hold Point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

2.08.09 All inspection, measuring and test equipments used by contractor shall be calibrated periodically depending on its use and criticality of the test/ measurement to be done. The Contractor shall maintain all the relevant records of periodic calibration and instrument identification, and shall produce the same for inspection by THDC. Wherever asked specifically, the contractor shall re-calibrate the measuring/test equipments in the presence of Engineer-in-charge / Inspector.

2.08.10 All the Type tests, Routine tests, Site tests, Commissioning/Pre-Commissioning tests, Acceptance tests, Special tests and any other tests mentioned in the technical specifications (not covered in the attached QA &I Requirements) shall be executed in the spirit it is defined in the technical specifications and they shall form part of the Quality Assurance Plan.

2.09.00 **Erection Manuals**

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

a) Erection strategy.

b) Sequence of erection.

c) Erection instructions.

d) Critical checks and permissible deviation/tolerances.

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

f) Bill of Materials

g) Procedure for erection.

h) Procedure for initial checking after erection.

i) Procedure for testing and acceptance norms.

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

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

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

2.10.00 Associated Document for Quality Assurance Programme:

2.10.01 Manufacturing Quality Plan Format NO..: QS-01-QAI-P-06/F1-R0
Field Quality Plan Format NO.: QS-01-QAI-P-06/F2-R0

2.10.02 Status of Items requiring Quality Plan and Sub-supplier approval
Format no.: QS-01- QAI-P-02/F1-R0

2.10.03 List of Items requiring Quality Plan and sub-supplier approval
Format no.: QS-01- QAI-P-01/F3-R0

2.10.04 Main Contractor's Evaluation Report
Format no.: QS-01-QAI-P-04/F1-R1

2.10.05 Sub-supplier questionnaire format no.: QS-01-QAI-P-04/F2-R1

ANNEXURE-CP

QA CO-ORDINATION PROCEDURE

As mentioned at Cl.2.01.02, a QA Co-ordination Procedure shall be adopted for smooth functioning QA&I activities as follows:

1. PURPOSE:

This document specifies procedure to be adopted for the coordination of QA&I activities relating to Electro-Mechanical Package of Vishnugad Pipalkoti Hydro Electric Project (VPHEP) to satisfy the QA requirements laid down in the Contract.

2. SCOPE:

This document shall specify procedure of:

- Level-1 & Level-2 vendor approval / finalization.
- Quality Plan:Bought-out items/Manufacturing items Approval/finalization.
- Field Quality Plan approval/finalization.
- Inspection/Testing of equipments/items.
- Dispositioning of Non-conformities.
- Dispatch clearance of equipments/items.
- QA documentation Package
- Quality audit & surveillance.

3. DEFINITIONS:

3.1 THDC/Consultant Inspector: Means THDC/Consultant's own inspector/duly authorized third party inspection agency.

3.2 **Resident Inspector:** Means THDC/Consultant's own inspector/ inspector of authorized third party posted in the country of origin of the equipment or manufacturing works and Consultant Inspectors at Regional Inspection Offices and at works.

3.3 **Level-1 sub-contractor/ sub-vendor/ sub-supplier:**
Vendors/Contractors/Suppliers of successful bidder on whom order shall be placed for complete system/equipment.

3.4 **Level-2 sub-contractor/ sub-vendor/ sub-supplier:**
Vendors/Contractors/Suppliers of Level-1vendors/ contractors/supplier

4. PROCEDURE:

4.1 CO-ORDINATORS AND CORRESPONDANCE

4.1.1. Overall QA co-ordinator of successful bidder for this contract shall be informed to the Owner within four weeks from the issue date of letter of award of work.

4.1.2. Web-based system for Quality Assurance & Inspection activities adopted by THDC India Ltd. shall be followed for implementation of present quality system or any updation from time to time.

4.2 VENDOR APPROVAL

4.2.1 List of items requiring Quality Plan and sub-vendor/ sub-supplier approval shall be furnished by Bidder covering scope of supply, their sub-vendors/sub-suppliers and quality plan requirements. This list shall be finalized with successful bidder during pre-award stage before award of work. However, the list of Level-2 sub-vendors shall be furnished by the Contractor after award of the work.

Vendors proposed by successful bidder and acceptable to THDC/ Consultant shall be put under 'APPROVED' category. Vendors not known to THDC/Consultant or with whom THDC/Consultant do not have past experience and for which details are required to be submitted by the Contractor, shall be put under 'DR' category (Details Required). Contractor's approved vendor shall be accepted in 'NOTED' category and indicated by 'N' by owner for this project based on the Contractor's experience with the vendor for the item without specific vendor approval.

Certificate of consent from vendors/ suppliers to execute the work proposed by the Contractor shall be submitted with above list.

4.2.2 The Contractor shall finalize vendors from the vendors list mutually agreed in Clause 4.2.1. The Contractor shall not propose any "DR" category or additional vendor in post-award stage for items for which there are three or more vendors identified as acceptable ("Approved"/"Noted") during pre-award stage, except in following circumstances/ cases:

i. Where any item is added on list of items for vendor approval or type/ design of an item is changed during detailed engineering.

ii. Where the Contractor is confronted with a situation such that supplies from already approved sources is not possible.

In such case, the proposal for additional vendor shall be made by Head (Quality) of the Contractor to Head (QA&I) of OWNER, furnishing reasons and justification for such consideration.

4.2.3 The Contractor shall submit complete vendor/ supplier details in enclosed prescribed format No. QS-01-QAI-P04/F2 for "DR" Category vendors in SINGLE submission to THDCIL for review and approval of vendors. The details will include following:

(a) Manufacturing & testing facilities, organisational set up including catalogue/drg. giving constructional details.

(b) System & procedure of proposed vendor followed for inspection & testing of various items covered in this scope.

(c) Contractor's Evaluation Report in the prescribed format No. QS-01-QAI-P04/F1-R1.

(d) Relevant POs placed by the Contractor and executed by the vendor.

(e) Vendor's own experience including Field Performance Report from the end-users for similar size/rating, application and material. Experience detail shall include PO details, date of supply and commissioning.

Additional details of vendor, in addition to above, if required, may also be asked by Owner for vendor assessment**.**

The submission of above details shall be as per mutually agreed schedule in line with project schedule requirements.

4.2.4 Above details of DR category vendors shall be furnished by the Contractor to THDCIL within six months of award of the contract by THDCIL, in case of items to be ordered in first nine months, prior to placement of purchase order on the vendor for other items. The vendor proposals in 'DR' Category, where complete details are not furnished within the above period shall be considered withdrawn by the Contractor. On receipt of complete vendor details in all such DR cases, THDCIL/ Consultant shall process the vendor proposals and shall furnish their decision within eight weeks from receipt of complete details.

4.2.5 Monthly progress report of vendor approval for vendors identified in 'DR' category shall be furnished by the Contractor's overall co-ordinator.

4.2.6 Within three weeks of release of Purchase Order for bought out items/ components, the Contractor shall furnish to THDC a copy of the Purchase Order without price details but together with detailed purchase technical specification and delivery conditions.

4.3 QUALITY PLANS

4.3.1 List of items requiring approval of Quality Plan by THDCIL shall be furnished by Bidder. This list shall be finalized at pre-award stage before award of the work. As detailed Engineering progresses, the list shall be adapted for addition/deletion of items.

4.3.2 The Contractor shall finalize a realistic schedule of submission and approval of Quality Plans based on project requirements within 6 weeks of date of LOA. The schedule shall be dovetailed with overall schedule of works in such a manner that the QP is approved at least 4 weeks prior to scheduled start of manufacturing of respective item and FQP is approved at least TWO months before scheduled start of respective field activity.

4.3.3 The Contractor shall submit to THDC/Consultant Quality Plans along with reference documents as per schedule of submission. The final submission of Quality Plans shall be furnished to THDC on a CD/DVD also in addition to hard copies.

4.3.4 Manufacturing Quality Plans shall be furnished by the Contractor along with all reference documents such as purchase specification/ details, approved drawing, data sheet and technical parameters, test procedure, manufacturer/plant standards, etc.

4.3.5 Monthly progress report of quality plan submission/approval shall be furnished by the Contractor's overall co-ordinator.

4.4 FIELD QUALITY PLAN

4.4.1 The Field Quality Plans for equipments and services shall be furnished by the Contractor and their Vendors so as to finalise the same at least 3 months prior to start of work and shall include the quality practices and procedures followed by them during various stages of site activities from receipt of material/equipment till final erection. The list of FQP to be approved by THDCIL shall include:

1. Material receipt & storage
2. Turbine & Aux.
3. Generator & Aux.
4. Penstock Inlet Valve
5. Main Inlet Valve (MIV)

6. EOT Crane
7. AC & Ventilation & smoke Exhaust System
8. Fire Fighting System
9. Oil Handling System
10. Electrical Balance of Plant Items
11. C&I Items (Receipt, Storage)
12. Gates
13. Gantry Cranes
14. Penstock

4.4.2 The Contractor shall furnish list of Erection contractor for THDC approval/ acceptance.

4.5 INSPECTION

4.5.1 All inspection call shall be furnished to THDC. THDC in turn shall forward calls to Consultant as per their requirements to take up inspection at various RIOs. The notice period for inspection of materials/components/equipments for witnessing of the CHP stages by THDC/Consultant at the Level-1 vendors/Level-2 vendor's works shall be as follows:

(a) Vendors of Indian origin	-	21 working days
(b) Vendors of Foreign origin	-	60 days (initial)
-do-	-	15 days (final)

4.5.2 Wherever THDC/Consultant resident inspectors are located at the Contractor's works, inspection notice shall be as mutually acceptable.

4.5.3 The Contractor shall issue inspection call notice to THDC QA Co-ordinator.

4.5.4 Where witnessing of the test is waived-off in writing by THDC, Contractor/vendors shall proceed with the test which shall be deemed to have been carried out in the presence of THDC/Consultant inspector and shall forward duly certified copies of the test reports to the concerned THDC/Consultant inspection office as follows:

a. For the tests conducted within the Contractor's premises shall be within 10 days.
b. For the tests conducted at vendors' premises shall be within 10 working days.

In case of any objection, the concerned THDC/Consultant-RIO office shall notify the same to the concerned the Contractor/vendors within 10 working days from receipt of the test reports.

4.5.5 For the witnessed tests, when the factory test at identified CHP stages have been satisfactorily completed including computation of test results wherever applicable, THDC/Consultant inspector shall sign jointly with the Contractor/vendors/ authorized representative (as applicable as per approved QAP) on the CHP Clearance/ Interim Inspection report in the format .

4.5.6 For the witnessed tests, in case of deviation, THDC/Consultant inspector shall convey their non-conformities in writing on the CHP Report itself for clarification by the Contractor /Vendors, who shall give due considerations to the objections raised and shall take corrective measures (as per the procedure laid down in clause 4.7 after due approval from THDC) to rectify the non-conformities and shall confirm in writing to the concerned inspection office on rectification of the objections raised. However decision of THDC shall be final and binding upon the Contractor/vendors within the purview of the contract requirements.

4.5.7 The Contractor will make available to the THDC/CONSULTANT inspector their relevant internal documents and plant standards/procedure relevant to the checks/tests carried out on material/items equipments. Further, the Contractor/vendors shall also ensure the availability of approved documents such as drawings/data sheets and approved Quality Plan etc. at the place of inspection.

4.5.8 **INSPECTION PLAN:** To facilitate advance planning of inspection of supplies, in addition to giving inspection notice at identified CHP stages as per approved QAP, the Contractor shall furnish three monthly rolling inspection programme every month indicating schedule dates of inspection at identified CHP stages. Such a programme shall be updated each month and a copy of the same is made available to the resident inspector/RIO as applicable. Such programme shall be confirmed by specific inspection call in accordance with clause 4.5.1 above.

4.5.9 Three-monthly inspection programme for shop manufactured & BOIs shall be furnished directly to THDC.

4.5.10 Contractor's QA shall furnish monthly inspection status report for previous month including pending calls and exception reports/NCR on or before 7th of every month.

4.6 **QUALITY AUDIT: CONTRACTOR /VENDORS** shall provide the necessary facilities to THDC inspector/team for carrying out of the Quality Surveillance and Audits as envisaged in the contract.

4.7 NON-CONFORMITY DISPOSITIONING PROCEDURE:

4.7.1 Whenever any deviation is observed with respect to relevant document and good Engineering practices, the same shall be referred along with justification to THDC/Consultant office where inspection call has been raised by the Contractor/vendors. The details shall be furnished in the format attached for THDC/Consultant review and necessary action. Non-conformity Report (NCR) can be raised irrespective of the CHP stages to the concerned inspection office in whose jurisdiction the item/equipment is being manufactured.

4.7.2 Non-conformities with respect to the site activities shall also be dealt with similarly except that the NCR shall be routed through THDC-FQA group.

4.8 Material Despatch Clearance Certificate (MDCC):

4.8.1 Upon satisfactory completion of all tests/inspection including type test as required by the approved documents (Cat-1 approved Quality Plan drawing/data sheet etc. as applicable) MDCC shall be issued by THDC.

4.8.2 As per Tech specification, no item shall be despatched by the Contractor without obtaining MDCC/dispatch clearance in CHP report from THDC/Consultant.

4.9 QUALITY ASSURANCE DOCUMENTATION PACKAGES:

The Contractor shall submit to THDC QA the Quality Assurance documents in two hard copies and two CD ROM/DVD.

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

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

		LEGEND: * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. ** **M:** MANUFACTURER/SUB-SUPPLIER **C:** MAIN SUPPLIER, **T:**: OWNER; **P:** PERFORM **W**: WITNESS AND **V:** VERIFICATION. AS APPROPRIATE, **CHP:** OWNER SHALL IDENTIFY IN COLUM "N" AS ' W"		DOC. NO.:	REV…… CAT…..
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER		FOR OWNER USE		
SIGNATURE				REVIEWED BY	APPROVED BY / APPROVAL SEAL

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

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

				DOC. NO.:		REV……
MANUFACTURER/ SUB-SUPPLIER	MAIN-SUPPLIER	**LEGEND:** * RECORDS, INDENTIFIED WITH "TICK" (√) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION. **LEGEND TO BE USED: CLASS # : A = CRITICAL, B=MAJOR, C=MINOR;** **'A'** SHALL BE WITNESSED BY OWNER FQA, **'B'** SHALL BE WITNESSED BY OWNER ERECTION / CONSTRUCTION DEPTT. AND **'C'** SHALL BE WITNESSED BY MAIN SUPPLIER (A & B CHECK SHALL BE OWNER CHP STAGE)	FOR THDC USE			
SIGNATURE				REVIEWED BY	APPROVED BY	APPROVAL SEAL

Project : Stage : Package : Contractor : Contractor No. :	STATUS OF ITEM REQUIRING QP& SUB-SUPPLIER APPROVAL	DOC. NO.: REV. NO.: DATE : PAGE :		

S. No.	Item / Service	QP/ Inspn. Cat. (I/II/III)	QP Submission Schedule / Approval schedule	Date of sub-mission	Date of commt Appl.	Status Code of sub-supplier (A/B/C)	Proposed Sub-suppliers	Place of manufacturing works	Approval Status	Sub-supplier detail submission schedule	Remarks

	Project : Stage : Package : Supplier : Contractor No. :	LIST OF ITEMS REQUIRING QUALITY PLAN AND SUB-SUPPLIER APPROVAL SUB-SYSTEM :	DOC. NO.: REV. NO.: DATE : PAGE :

S. N.	Item	QP/ Insp. Cat.	QP No.	QP Sub. Schedule	QP approval schedule	Proposed sub-supplier	Place	Sub-suppliers approval status / category	Sub-supplier Details submission schedule	Remarks

LEGENDS

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

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

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

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

2. **QP/INSPECTION CATEGORY**:

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

CAT-II: For these items the Quality Plans are approved by THDCL. However no inspection by THDCL is envisaged, THDC reserves the right to inspection of items, if desired by THDC. The final acceptance by THDCL shall be on the basis review of documents as per approved QP.

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

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

MAIN CONTRACTOR'S EVALUATION REPORT
(For Proposed Sub-Supplier)

1. MAIN CONTRACTOR : : M/S_____

2. PACKAGE & PROJECT NAME : _____

3. BRIEF SPEC. OF EQUIPMENT / ITEM / PROCESS WITH MODEL / TYPE/ RATING / CAPACITY/ SIZE/ TONNAGE ETC. (AS APPLICABLE) : _____

4. PROPOSED SUB-SUPPLIER'S NAME & WORKS ADDRESS : _____

5. BASIS OF RECOMMENDATIONS:

a) Main contractor's own supply experience

REFERENCE LIST (EXPERIENCE FOR THE PARTICULAR TYPE OF EQUIPMENT / ITEM /PROCESS) OF MAIN CONTRACTOR:

CUSTOMER NAME, PROJECT NAME	TYPE / RATING / MODEL/ CAPACITY/ SIZE / TONNAGE ETC (AS APPLICABLE)	SUPPLIED QUANTITY	DATE OF SUPPLY	NO. OF YEARS IN OPERATION/ DATE OF COMMISSIONING (*)

b) In absence of own supply experience:

ENCLOSE MAIN CONTRACTOR'S ASSESSMENT REPORT AS PER THEIR VENDOR APPROVAL SYSTEM (**)

NAME : _____ DESIG. : _____ SIGN : _____ Date: _____

List of Encl.: (Pl. Tick)

(*) a. User Certificate ☐

(**) b. Self Assessment Report ☐

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

Name of Equipment / Item / Process with Model/ Type/ Rating / Capacity/ Size/ Tonnage etc. (As applicable):

_____

Trade Name of Product (if any) : _____

_____

1. **Name of Proposed Sub-Supplier**: _____

   Website: _____

2. **Address of Regd. Office:**
   _____
   _____
   _____

   Details of contact person:
   Name_____
   Mobile no._____
   Desig._____
   E-mail:

3. **Branch/ Liaison office in Delhi/NCR**
   _____
   _____
   _____

   Details of contact person:
   Name_____
   Mobile no._____
   Desig._____
   E-mail:

   Weekly off day _____

4. **Address of Works where Item is being manufactured**
   _____
   _____

   Details of contact person:
   Name_____
   _____
   Mobile no._____
   Desig._____
   E-mail:

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

5. **Details of Proposed Works:**

a. Year of Establishment of present works : _____
b. Year of Commencement of Manufacturing at the above works : _____
c. Details of change in works address in past, if any : _____

d.. TotalArea / Covered Area : _____
e. Details of covered area like no. of sheds, Area of each shed etc. _____
f. Electric power- Connected load: _____
Electric power- Stand by load & system: _____

6. **Annual Turnover & Profit in past three years** : _____ _____ _____

7. **Do you have in-house Department for:**

a) Design Yes/No
b) Research & Development Yes/No
c) Quality control/Inspection Yes/No
d) After Sales Service Yes/No

8. **Shift works per day** One/Two/Three

9. **Present Manpower Status:**

Division Status	Graduate		Diploma	Skilled	Un-Skilled	Remarks
	Technical	Non-Technical				
Design						
Production						
Quality Control/ Inspection						
After Sales Service						

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

a. Organization chart of the proposed works is enclosed as Annexure: _____
b Organization chart of QA / QC Deptt. is enclosed as Annexure: _____
c. List of Qualified Welders with process etc. is enclosed as Annexure: _____
d. List of Qualified NDT personnel with area of specialization is enclosed as Annexure: _____

10. **Brief details of items manufactured:**

Sl. No.	Item & Material (Type/Size/Rating/Model/ Capacity /Tonnage , as applicable)	Installed Capacity	Annual Production Capacity	Annual Production for last Three years		
				I	II	III

11. **Details of foreign Collaboration, if any:**

Sl. No.	Product	Name & Address of Collaborator	Collaboration		
			Scope	Year	Valid upto

12. **Type Test report for the proposed product (similar or higher rating)if applicable is enclosed as Annexure: _____**

13 **Approval / Certification by National / International standards / Accredited agency for the proposed product (if applicable) is enclosed as Annexure: _____**

14. **Statutory / mandatory certification for the proposed product (if applicable) is enclosed as Annexure: _____**

15. **Supply Experience list of the proposed product (similar or higher rating) is enclosed as Annexure: _____**

[List shall include Item description, (Type/Size/Rating/Model/Capacity/Tonnage, as applicable), Customer name, Quantity, Year of Supply and Year of commissioning]

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

16. **End User's operational feedback certificate for the proposed product is enclosed as Annexure**: _____

17 **List of equipment & machinery specific to the proposed product is enclosed as Annexure:** _____

(List shall include name of equipment, capacity & nos. etc.)

18. **Process Flow Diagram indicating in-house & outsourced process enclosed as Annexure:**_____

19 **General manufacturing facilities available in-house**:

Sl. No.	Description of machine	Type /Capacity / Size / Rating etc as applicable	Number
a)	Material Handling Mobile Crane Fork Lift Over Head Cranes		
b)	Metal Cutting & Bending		
c)	Casting		
d)	Forging		
e)	Fabrication		
f)	Welding		
g)	Machining		
h)	Heat Treatment		
i)	Surface Cleaning Sand Blasting Shot Blasting Pickling		
j)	Painting		
k)	Metal Coating		

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

l)	Packing		
m)	Other, if any		

20.

a. **Inspection & Testing Facilities available in-house:**

Sl. No.	Description	Capacity & Nos.	Make & year of Mfg.	Calibration Status	Validity period

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

b. List of Testing & Inspection Facilities outsourced, if any with Source of testing and Description enclosed as Annexure: _____

21. **Storage of finished goods (covered / open) :** _____

22 **List of the source / make with location of major raw material, bought out items and out sourced process enclosed as Annexure:** _____

23. **Quality management:**

23.1 **General**

23.1.1. Work Instruction for different processes available. (Y/N). ___

If yes, enclose list as Annexure_____

23.1.2. Evaluation system for raw material/bought out item's supplier is available. (Y/N) _____

23.1.3. Records generated during inspection maintained & available for review (Y/N) _____

23.1.4 Statistical quality control techniques used (Y/N) _____

23.1.5 ISO certificate for the works available (Y/N). ____ If yes, enclose copy as Annexure_____

23,2 **Corrective action**

23.2.1 Specifically confirm whether System for identification & disposition of Non Conformity in the process / product is available. (Y/N) _____

23.2.2 Specifically confirm whether System for Customer complains & their satisfactory disposal is available. (Y/N) _____

23.3. **Documentation Control**

23.3.1 Procedure available for documentation control (Y/N) ___

23.4. **Control of Inspection, Measuring & Testing equipments**.

23.4.1 Procedure for calibration of testing & measuring instrument available. (Y/N) ___

24. Any Special Information: _____

SUB-SUPPLIER QUESTIONNAIRE
(To be filled in by the Proposed Sub Supplier)

26. **I CERTIFY THAT THE INFORMATION SUPPLIED HEREIN (INCLUDING ALL PAGES ATTACHED) IS CORRECT TO THE BEST OF MY KNOWLEDGE.**

SEAL

SIGNATURE_____
NAME_____
DESIGNATION_____
MOBILE NO _____
EMAIL _____

M/S._____
PLACE_____

DATE_____

LIST OF ENCLOSURE:

Certification by Main Supplier: Above information have been verified and found in order / minor changes which have been marked and initialed on this form itself / observed the following discrepancies.

Name : _____ **Designation :** _____**Signature :** _____**Date :**_____

NOTE :

1. ***COLUMN SHALL NOT BE LEFT UNFILLED..IN CASE OF NOT APPLICABLE / NOT AVAILABLE, THE SAME SHALL BE INDICATED IN THE PROVIDED SPACE.***
2. ***IN CASE PROVIDED SPACE IS NOT ADEQUATE, INFORMATION SHALL BE PROVIDED AS AN ATTACHMENT.***
3. ***PRODUCT CATALOGUE FOR THE PROPOSED EQUIPMENT/ITEM/PROCESS,IF AVAILABLE, SHALL BE ENCLOSED***

1. MATERIALS

The construction materials for all equipment shall be of a quality suitable for the purpose of each item and shall be free of all defects. Material types may be changed at the design stage only with the Employer's approval and only if the new materials can be proven to provide at least the same factor of safety for the equipment.

1.1 Castings, Forgings & Plates:

All castings shall be true to pattern, of good finish, and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks, or other injurious defects, and shall be satisfactorily cleaned for their intended purpose. The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. The surface of castings, which do not undergo machining, shall be free from foundry irregularities, such as projections, ridges, hollows, honeycombing.

The structure of the casting shall be homogeneous and free from excessive nonmetallic inclusions. An excessive segregation of impurities or alloys at critical points in a casting will be caused for its rejection.

The materials for each kind of casting shall be in accordance with the followings, or approved equal.

Iron Castings ASTM Specification/ equivalent International/ national standard.

Carbon Steel Castings ASTM Specification/ equivalent International/ national standard.

Stainless Steel Castings ASTM Specification number / equivalent International/national standard and grade, composition, shall be proposed.

The largest fillets compatible with the design shall be incorporated wherever a change in section occurs. Tool marks or tearing of the mental by the finishing tool will not be permitted on the surface of fillets. Grinding or polishing shall be required to remove such marks if they occur. All finished surfaces of forgings shall be smooth and free from tool marks.

Steel plate used for pressure vessels shall meet ASTM Specification/ equivalent International/national standard.

Stainless steel plates shall be in accordance with ASTM Specification/equivalent International/national standard. The grade, specification number, and chemical composition shall be as per tech. specifications.

2.	**TESTS ON MATERIALS**
2.1	**Non Destructive Testing** Unless otherwise specified in these Technical Requirements, all non-destructive testing shall be carried out in accordance with the latest edition of the following standards:
2.1.1.	**CASTINGS:**
2.1.1. (a)	**Radiographic examination:** ASTM E 446: minimum quality level 2 except for category A for which the minimum quality level shall be 3 -ASTM E 186: quality levels as above -ASTM E 280: quality levels as above
2.1.1. (b)	**Ultrasonic examination:** -ASTM A 609: minimum quality level 2
2.1.1. (c)	**Magnetic particle examination:** - ASTM E 125: minimum quality levels: type I degree 0, other types degree 1
2.1.1. (d)	**Dye penetrant examination:** - ASTM E 165: evaluation to be agreed upon at the inspection and the acceptability will be subject to agreement between the Employer's Representative and the Contractor.
2.1.2.	**FORGINGS:**
2.1.2 (a)	**Ultrasonic Examination** ASTM A 388: acceptability of any recordable indication shall be at the Employer's Representative's judgment
2.1.2. (b)	**Magnetic particle examination:** ASTM A 275: evaluation to be agreed upon at the inspection and the acceptability will be subject to agreement between the Employer's Representative and the Contractor.

2.1.3.	**PLATES :**
2.1.3(a)	**Ultrasonic examination:** ASTM A 435
2.2	**Mechanical Tests and Chemical Composition** All principal materials, such as plates and sections subject to intermediate and high stresses, main castings and forgings, shall be subject to the mechanical tests prescribed by the relevant Standards. Where no definitive specifications are given, test pieces shall be obtained as required by the Employer's Representative. Mill test certificates for chemical composition of the material shall be submitted. Test specimens and sample shall be plainly marked to indicate the material they represent and, if required, shall be properly boxed and prepared for shipment.
3	**TEST CERTIFICATES AND REPORTS**
3.1.	**General** The Contractor shall carry out all tests as specified and shall record all test results in a satisfactory manner. Customer hold points shall be witnessed by the Employer together with the Employer's Representative.
3.2.	**Certificates** The Contractor shall furnish copies, as specified, of all mill certificates, material test certificates and welding rods certificates. The test certificates shall be suitably identified with the component parts for which the materials are to be used and shall be prepared in such a way that it can easily be determined, if the applicable specifications or standard have been complied with.
4.	**WORKMANSHIP:**
4.1	**General** The materials shall be accurately finished and shall be in accordance with the highest current technical Standards. In particular, homologous parts shall be interchangeable with each other.

4.2 Welding

All welds shall comply in all respect with ASME or EN standards. The welding work shall be done by arc welding and the work shall be free from pinholes, cracks and any other notable defects. The qualification test of welding operation and welders shall be in accordance with the latest edition of Section IX of the ASME Boiler and Pressure Vessel Code or other equivalent standards. Welding rods to be used in hand welding shall be a heavy coated type suitable for welding of all sections.

Plates to be joined by welding shall be accurately cut to size and rolled by pressure to the proper curvature, which shall be continuous from the edge. Flattening in the curvature along the edges with correction by blows will not be allowed. The dimensions and shape of the edges to be joined shall be such as to allow thorough fusion and complete penetration, and the edges of plates shall be properly formed to accommodate the various welding conditions.
The Contractor shall submit for approval the welding procedure, base materials, welding rods and non-destructive tests of welding.

4.3 Welding Equipment at Site:

The welding equipment at Site shall include all devices necessary to avoid arc extinguishing and to ensure a steady supply voltage within one tenth of five percent. Voltage shall not be higher than 80 V.

4.4 Electrodes:

The Contractor shall indicate in all detail drawings the type and size of electrode he proposes to use for shop and/or field welding. The electrodes shall be shipped suitably packed in weatherproof metal boxes and kept inside their box up to their use. Should any box be damaged, the electrodes shall be replaced. The electrodes to be used shall be maintained in a drying oven at a temperature of about 90°C. Electrodes exposed outside for more than four hours shall be returned to the oven.

4.5 Stress Relieving

All cold rolled plates, with thickness greater than 35 mm and/or 0.8 percent of the rolling diameter, to be welded to each other in the workshop shall be stress relieved after welding and before machining in order to eliminate the internal stresses. In all the other cases, stress relieving shall be made when required by ASME Code for Unfired Pressure Vessels. Stress relieving methods shall comply with ASME Standards.

4.6 Non Destructive Testing

4.6.1 The tests that shall be carried out are those indicated in the Technical Requirements. If no indication is given, the welds shall be tested according to the joint efficiency adopted in the calculations, following the indications of ASME Section VIII Table UW12. All welded joints assuring tightness shall be inspected or tested by magnetic particle or dye penetrant. The Contractor shall indicate in the Fabrication and Installation Drawings the type of non-destructive testing to be conducted. The following prescriptions shall apply:

4.6.2. Radiographic Examination

According to ASME Section VIII par. UW-51 and for spot examination according to ASME Section VIII par. UW-52.

4.6.3. Ultrasonic Examination

According to ASME Section VIII Appendix U. The ultrasonic examination will be considered equivalent to the radiographic examination for the purpose of the weld efficiency factor determination, provided that the following conditions are met:

- All welds with indications exceeding 50% of the reference level shall be radiographed following the prescriptions of ASME Section VIII par. UW-51;
- Not considering the above radiographs, 10% of the welds carried out in the workshop and 20% of the welds carried out at Site shall be radiographed.
- Welds shall be divided into groups, according to the welding procedure and position of the welds, and in agreement with the Employer's Representative. In any case, welds carried out on different materials and/or by different welders or welding machines and/or with electrodes of different quality shall not be considered as pertaining to the same group.
- The influence of thicknesses, castings and weld positions on the grouping shall be agreed with the Employer's Representative. The Employer's Representative will choose the welds and/or the groups on which the radiographic examination shall be carried out. Should a single unacceptable defect be found out, the whole group shall be radiographed, without considering these radiographs as included in the above percentages.

- Crossing point welds shall be 100% radiographed; also these radiographs are not included in the above percentages. All welds to be radio graphically examined will be countermarked with identification marks appearing in the radiographic film and the marks shall not be removed before the approval of the relevant weld has been given by the Employer's Representative. The Contractor shall submit to the Employer's Representative the radiographic film of all welds to be approved, together with a localisation map of the relevant identification marks. All radiographic films shall become the property of the Employer. Welds performed on automatic resistance butt-welding machine shall undergo an indirect control providing sampling pieces. For each piece, mechanical tests and other tests according to Contractor's practice shall be performed on the welding. In case one welding proves to be defective, the adjacent welds shall be cut out and tested. All defects detected by inspection shall be fully corrected and inspected again until the correction has been approved by the Employer's Representative.

4.6.4 Hydrostatic Testing:

- Hydrostatic testing shall be conducted as per Employer's Technical requirement. Details of the testing procedures and test beds to be used shall be furnished by the Contractor to be approved by Employer's representative. All arrangements for Hydrostatic testing including devices, equipments, facilities etc. shall be at Contractor's account.
- The pipe shells, bends, etc. shall be subjected to hydrostatic test pressure, equal to 1.5 times the design pressure.
- Before applying pressure, the equipment shall be inspected to see that all joints are leak proof and to ensure that all low pressure filling lines and other appurtenances that shall not be subjected to the test pressure, are disconnected.
- After being completely filled with water, the pressure in steel liner assembly or the part to be tested, shall be applied slowly at a uniform rate up to the design pressure for a minimum of 5 minutes or sufficient time to check all the points for any defect / leakage.

- The pressure is then brought down to 75% of the design pressure and then raised to the test pressure (1.5 times the design pressure) and held for atleast 15 minutes or sufficient time for inspection of plates, all welded joints and connections and all regions around openings.
- All defective welded seams and all defects in steel plates discovered during the hydrostatic pressure test shall be marked and after draining out the water they shall be satisfactorily repaired.
- After repair and radiography, all sections shall again be subjected to a hydrostatic pressure test as above. This procedure shall be repeated till satisfactory results are obtained throughout.

5. SURFACE PREPARATION AND PAINTING

(Also see Clause No. 16 "Protection and Preservative Shop Coating")

5.1.1. Shop Treatment:

The surface of steel parts shall be sand blasted. A primer coat of zinc rich epoxy approved by the Design & Engineering shall be applied cold to all surfaces. Machine finished surfaces of the Equipment and the portions to be embedded in concrete shall be adequately protected by rust preventive means.

5.1.2. After Shop Assembly:

Painted surfaces shall be touched up by sand blasting and complete painting treatment if they have been damaged during transport or handling, and coated with two or three top coats (depending on paint thickness) of bituminous epoxy paint. The total thickness of paint including top coat shall be as specified in tech. specification.

5.2 Spiral Casing/ Draft Tube:

5.2.1. Surface Preparation:

- Weld spatters, burrs or any other objectionable irregularities shall be carefully removed or repaired by suitable means before cleaning.
- All oil, grease and dirt shall be removed from the surface by the use of clean mineral spirits, xylol or white gasoline followed by wiping with clean wiping materials, except that for surfaces, which require Coal tar coatings, the cleaning solvent shall be xylol.

- Following the solvent cleaning, the surfaces to be painted (inner surface and outer surfaces exposed to weather) shall be cleaned to base metal to remove all rust, mill scale and other tightly adhering objectionable foreign materials by sand blasting or grit blasting to a uniform finish equivalent to SA 2.5 or as specified in IS: 9954. A clean and dry gypsum and salt free quartz sand having grain size 0.7 to 1.5 mm shall be used for sand blasting. Blast cleaning shall be accomplished with abrasives of such particle shape, hardness and gradation as to effectively clean the metal and have roughened surface suitable for tenacious adhesion of subsequent coating. The primer coat of paint shall be applied on surfaces cleaned as above, as soon as possible after such preparation has been completed, but in any case prior to deterioration of the prepared surface.

- Any grit or dust remaining from the cleaning operation shall be completely removed from the surface by brushing, air blowing, suction or other effective means before the surfaces are accepted for painting.

- In the event of rust formation or when the surfaces become otherwise contaminated in the interval between cleaning and painting, re-cleaning shall be required to be done.

6. LUBRICATION

All components in movement shall be duly and efficaciously lubricated. Greasing or lubricating points shall be grouped for all equipment in easily accessible positions. Pressure gauges and level indicators shall be installed in a noticeable place to acknowledge a sudden drop in level or pressure and prevent any damage that may occur.

Dipsticks, leakage drip plates, lubricant sight glasses shall be installed throughout the Plant. All the lubrication equipment shall be tested, before placing into service, at a pressure of 1.5 times the maximum operating one. The Contractor shall entrust a lubrication schedule for the Equipment, showing the recommended frequency of application and types and grades of required lubricants. The recommended lubricants shall be approved by the Employer's Representative before requiring their supply. As a general rule lubricants of Indian manufacture shall be preferred.

Type of oil and grease shall be reduced to a minimum so as to facilitate

maintenance, and shall be available in the local market. After the Employer's Representative's approval, the Contractor shall supply all first filling oil and grease. With the first filling it is intended the 125% of the quantity necessary for the operation of the equipment.

7. TESTS

Shop Tests:

The following tests and inspections shall be carried out:

- Visual inspection of embedded parts, EOT Cranes
- All welds shall be inspected;
- All embedded parts shall be checked for dimensions straightness and roughness at the complete trail assembly position;

** For EOT Crane also refer **"QA Requirement-Mechanical Equipment Material Procurement & Manufacture)"**.*

The Employer or his Representative may attend to some or all tests and inspections.

8. MANDATORY/ RECOMMENDED SPARE PARTS:

All the spare parts furnished by the contractor shall be interchangeable and shall be made of same material & workmanship as the corresponding part of the equipment furnished.

9. SHOP ASSEMBLY AND TESTS

9.1 The sub-assemblies and parts shall be assembled and tested in shop to ensure that parts are correctly fabricated and properly aligned. Prior to shop assembly and testing the contractor shall submit for review an outline of the procedures and tests, which are planned to be performed to demonstrate the fulfillment of the requirement of the specifications. The cost of carrying out the tests shall be borne by the contractor. However, shop assembly testing and test of bought out items would be carried out at the instruction and discretion of the OWNER or his authorized representative.

9 .2 All parts of assemblies like of Draft Tube, Draft Tube Elbow Liners, Draft Tube Cones, Spiral casings, Distributor/ Guide Apparatus and appurtenances including head cover, bottom ring, wicket gates and

operating rings, Guide Bearing and Shaft Seals etc. shall be trial assembled at works of manufacturer making complete assembly of the item so as to allow for adjustment of various dimensions to make them conform to the designed dimensions, fits, tolerances, surfaces finishing, clearances etc. (if required dummies shall be used by the manufacturer for trial assembly).

Parts of above assemblies shall be match-marked for their relative position in order to facilitate their assembly as per tech. requirement in the field before despatch.

9.3 **PULLEY ASSEMBLY**

Pulleys, shafts, shafts brackets bushing/bearing assembly shall be carried out in the shop and checked for dimensional accuracy, fits and tolerances of mating components.

10. UNIT MARKING, MATCH MAKING AND TRANSPORTATION DESIGNATION

Each parts of assembly like Elbow Liners, Draft Tube Cones, parts of Guide Apparatus etc. which are to be transported as a separate piece, shall be marked to show the unit of which it is a part and match marked to show its relative position in the unit to facilitate assembly in the field. Unit marks and match shall be made with heavy steel stamps and paint.

Each piece, sub-assembly or package transported separately shall be labeled or tagged with transport consisting of the specification number, the marks number of such pieces and number of parts grouped of such sub-assemblies contained in package.

11. RATING PLATES, NAME PLATES & LABELS

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

11.2. Each item of plant shall be provided with name-plate or label designating the service of he particular equipment. The inscriptions shall be approved by the Employer or as detailed in appropriate section of the technical specifications.

11.3. Such name-plates or labels shall be of white no hygroscopic material with engraved black lettering or alternately, in the case of indoor circuit breaker, starter, etc. of transparent plastic material with suitably coloured lettering engraved on the back. The name plates shall be suitably fixed on both front and rear sides.

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

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

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

11.7. Valves and strainers shall be identified by Employer's tag number of a metal tab permanent attached to non pressure parts such as the yoke by a stainless steel wire. The direction of flow shall also be marked on the body.

11.8. Safety and relief valves shall be provide with the following:

a) Manufacturer's identification.
b) Nominal inlet and outlet sizes in mm.
c) Set pressure in Kg/cm^2 (abs.).

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

12. TOOLS AND TACKLES

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

The price of each tool/tackles shall be deemed to have been included in the total bid price. These tools and tackles shall be separately packed and sent to site. The Contractor shall also ensure that these tools and tackles are not used by him during erection, commissioning and initial operation. For this period the Contractor should bring his own tools and tackles. In case these tools and tackles are used by the Contractor during erection, commissioning or initial operation the same shall be refurbished repaired/replaced as required to the satisfaction of the Employer before handling over to the Employer. All the tools and tackles shall be of reputed make acceptable to the Employer.

13. WELDING

13.1. If the manufacturer has special requirements relating to the welding procedures for welds at the terminals of the equipments to be per formed by other the requirements shall be submitted to the Employer in advance of commencement of erection work.

14. COLOUR CODE FOR ALL EQUIPMENTS/ PIPINGS/ PIPE SERVICES

All equipment/ piping/ pipe services are to be painted by the Contractor in accordance with color and coding scheme given in Employer's Requirement.

15. SURFACE TREATMENT AND COATINGS

Please refer Annexure-'A' of this sub-section.

16. PROTECTION AND PRESERVATIVE SHOP COATING

16.1. Protection

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

16.2. Preservative Shop Coating

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

16.2.1. Transformers and other electrical equipments if included shall be shop finished with one or more coats of primer and two coats of high grade resistance enamel.

16.2.2. The finish colors shall be as per manufacture's standard, to be selected, specified and approved by the Employer.

16.2.3. Shop primer for all steel surfaces shall be selected by the Contractor, after obtaining specific approval of the Employer including the quality of primer proposed to be applied.

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

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

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

17. PACKING & TRANSPORTATION

All the equipments shall be carefully packed in robust packing suitable for long time transportation by sea, rail and land. The equipments shall be completely protected against moisture and rust from salt water and rain. The same precaution and care shall be taken for the Equipment (including components), which cannot be packed or crafted.

The spare parts shall be packed and crated firmly to withstand storage for a long time, and those in need of rust preventive treatment shall be so treated.
The spare parts shall be packed separately from other articles and absolute care shall be taken to prevent spare parts being packed or crated in the same box or crate with the Equipment or the installation materials. Packages of spare parts shall carry notation, which clearly indicated that the contents are spare parts and shall be accompanied by a list of contents, which sets forth directions for storing.

The contractor shall take into account the limitations if any for port handling or road load bearing capacities.

Annexure-'A'

Quality Assurance & Inspection Requirements of EM Equipments: General Tech. Requirement

SURFACE TREATMENT AND COATINGS

1.00.0. The present specifications apply to equipment and spare part surface coating. They define surface coating, the types of recommended coating, and the associated guarantees. In any case, the Contractor shall submit to the Employer his coating schemes.

1.01.0. CORROSION PROTECTION:

The Contractor shall take all necessary favorable measures to protect equipment from all abnormal corrosion taking into account project specific risks.

In particular, the Contractor shall choose the materials most suited to this project and shall submit a modification request to the Employer when the materials indicated in the specifications are considered unable to guarantee its behaviour against corrosion.

1.02.0. Equipment in Contact with Reservoir Water

For all equipment on the water conveyance circuit (trash racks, valves, pipes, pump turbines instruments), the use of uncoated carbon steel is prohibited, even where corrosion allowance is planned. If he considers it necessary, the Contractor may apply stainless steel cladding to some carbon steel parts, or manufacture these parts in solid stainless steel.

If maintenance is unsure because of peculiar equipment arrangement, or if the equipment cannot easily be shutdown, the Contractor may submit to the Employer, alternative corrosion protection methods, so that vulnerable surfaces can be protected effectively.

1.02.01. Outdoor Exposed Equipment

Among these equipment can be distinguished:

- those figuring as the subject of a particular specification, and for which the nature of materials and corrosion protection is clearly defined,
- those which, unlike the above, are not functional in nature and so are not subject to the same attention regarding problems of corrosion: parapets, gratings, lighting poles, etc.

Even this second category of equipment shall be subject to particular attention with regard to choice of materials and corrosion protection.

In general, attention shall be paid to taking constructive measures or acquiring standard equipment, whatever the function, to avoid any water build-up. Such constructive measures are, for example:

- for constructive using structural sections (dam gates, stoplogs), that all horizontal sheet metal sections have drainage holes at regular intervals;

- for auxiliary structures, embedding holes shall be completely filled with concrete, taking care to avoid any break in corrosion protection where concrete is exposed to the air.

2.00.00. GENERAL:

The Contractor shall provide a complete and reliable surface treatment of the equipment furnished for corrosion protection.

Surface protection shall comprise:

- a surface preparation phase with mechanical cleaning, grit blasting or chemical cleaning,

- a surface treatment phase with either metallizing and application of one or two priming coats suited to the type of metal surface, or application of priming coat,

- an application phase with several coatings of products, including final colored coat.

Surface protection shall be performed either in the Contractor's shops or on site, as per Employer’s Requirement (ER), with the necessary precautions taken.

Finishing touch-ups shall be performed on site upon completion of erection.

3.00.00. SURFACE TREATMENT:

All surfaces to be coated shall first be mechanically or chemically cleaned.

3.01.00. Mechanical Cleaning:

Surfaces shall be mechanically cleaned using one of the following methods:

- shot-blasting or grit blasting,
- Scraping, stripping, mechanical brushing.

3.01.01. Shot-blasting or Grit blasting:

If mineral abrasives are used, they shall be selected in compliance with the prevailing regulations concerning workers' safety.

The required care levels of surface states after cleaning are defined by the illustrations in standard ISO 8501, or equivalent. The required care shall be as follows:

- preparation of steel surfaces to be imbedded set in concrete = Level 1,
- preparation of steel surfaces to receive definitive protection = Level 2.5,
- preparation of steel surfaces to receive metallized protection = Level 3.

The roughness of the cleaned surfaces shall be Ra = 12.5 μm, except for surfaces that shall be metalized later, for which the roughness shall be Ra = 6.3 μm.

3.01.02. Scraping, Stripping, Mechanical Brushing:

This type of cleaning shall concern:

- Parts to be set in concrete, which shall not be coated.

These parts shall be brushed immediately prior to concreting.

- Repair of defective surface coating. In this case, cleaning by scraping, stripping or brushing shall only be performed if shot-blasting or grit blasting is impossible.

The required care shall be as follows:

- St 2 for surfaces which shall subsequently receive a definitive coating.
- St1 for surfaces to be set in concrete with no surface protection.

After cleaning, all surfaces shall be thoroughly dusted.

3.01.03. Surface Protection Repair:

Before surface protection is repaired, the old protection shall be partially or entirely removed. A new defects liability period shall start as soon as the zone in question has been repaired.

The old coating shall be completely removed by shot-blasting or grit blasting, in compliance with the specifications in 3.01.01.

If this process is impossible, the old coating shall be removed by scraping, stripping or mechanical brushing, in compliance with the specifications in 3.01.02.

4.00.00. CHEMICAL CLEANING:

All traces of pollution shall be removed with solvents (degreasing, neutralisation). The surfaces shall then be rinsed and dried (with special cleaning paper).

The Contractor shall submit, for the Employer's approval, a list with the characteristics of the solvents that he intends to use.

5.00.00. SURFACE TREATMENT:

Immediately after surface preparation, the Contractor shall employ one of the following three surface treatment processes:

6.00.00. METALLIZING:

Metalizing shall be performed within 2 hours after preparation.

The chemical composition of the metal used shall be: 85 % Zinc - 15 % Aluminum. The thickness shall be 120 µm.

Application shall be by spray gun in compliance with ISO standards R 2053.

After metalizing, pores shall be plugged by applying a wash primer, or, if the equipment is intended for immersion, by applying a thin coat of zinc epoxy (max. 20 µm).

7.00.00. HOT GALVANIZING:

This coating performed by quenching shall have the following characteristics:

- minimum unit mass : $5 g/dm^2$,
- average thickness : 70 µm

This process shall be used when metalizing cannot be performed under satisfactory conditions.

8.00.00. PRIMARY COAT APPLICATION:

This coating shall have the following characteristics:

- product : zinc epoxy coat,
- thickness : minimum 40 µm.

9.00.00. APPLICATION FOR THE PROTECTION:

The Contractor shall carefully control relative humidity and temperature before and during applying any coating. In any case, the relative humidity shall not exceed 80 %.

All traces of condensation shall be eliminated before protection is applied. If the relative humidity remain between 50 and 80%, the first coat shall be applied four (4) hours after the surface preparation.

The undercoats or finish coats shall be applied in compliance with the drying time required between each application.

10.00.00. TOUCH-UPS:

If more than 20 % of the total surface area of a given zone shall be touched-up, the Contractor shall replace the surface treatment over the entire surface.

11.00.00. PROTECTION OF SURROUNDING SURFACES:

The Contractor shall take every measure to protect the surrounding equipment and surfaces from product spattering, and from any damage caused by the surface preparation that he performs.

Equipment or surfaces that are soiled or deteriorated in spite of these measures shall be repaired or cleaned, or if this is impossible, replaced at the Contractor's expense.

12.00.00. CARBON STEEL – STAINLESS STEEL CONNECTION:

When carbon steel and stainless steel parts are connected, the surface coating shall be prolonged by 50 cm on the stainless steel part.

13.00.00. TYPES OF COATING:

The coatings to be applied, except when expressly stipulated otherwise in the equipment specifications, shall be defined as follows:

13.01.00. CARBON STEEL SURFACES IN CONTACT WITH WATER:

System chosen	Thickness
• 1 zinc epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The systems minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.02.00. CARBON STEEL SURFACES IN CONTACT WITH AIR AND INSTALLED OUTSIDE:

System chosen	Thickness
• 1 epoxy priming coat	40 µm
• 2 or 3 coats of epoxy-coal pitch finishing paint	2 x 225 or 3 x 150 µm

The systems minimum thickness shall be 450 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.03.00. CARBON STEEL SURFACES UNDER COVER THAT STILL RISK CONDENSATION:

System chosen	Thickness
• 1 epoxy priming coat	40 µm
• 2 coats of colored solvent epoxy pitch	2 x 150 µm

The systems minimum thickness shall be 300 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.04.00. CARBON STEEL SURFACES UNDER COVER WITH NO RISK OF CONDENSATION:

System chosen	Thickness
• Zinc epoxy priming coat	50 µm
• 2 coats of colored solvent epoxy pitch	2 x 100 µm

The systems minimum thickness shall be 200 µm.

The complete protection shall be applied in the shop, except when expressly waived by the Employer, and on site intervention shall be limited to touch-ups.

13.05.00. CARBON STEEL SURFACES IN CONTACT WITH OIL:

System chosen	Minimum thickness
• 2 coats of epoxy-polyamide paint containing aluminum	2 x 75 µm minimum

The contractor shall ensure that the paint chosen is compatible with the oil in contact.

The complete protection shall be applied in the shop.

13.06.00. TEMPORARY PROTECTION OF THE GROOVES:

The grooves, along with an area from 100 to 150 mm on either side of them, shall receive a temporary protective coating, according to the following system:

System chosen	Minimum thickness
• 1 coat of weldable epoxy-zinc paint	40 µm

The complete protection shall be applied in the workshop.

13.07.00. TEMPORARY PROTECTION FOR MACHINED SURFACE:

The surfaces shall be degreased, rinsed and dried before application of the temporary protective coatings.

System chosen	Minimum thickness
• 2 coats for oxidizing surface	2 x 35 µm
• 1 coat for non-oxidizing surface	1 x 35 µm

The protection shall be applied in the shop and eliminated on site before erection, using a rag impregnated with a solvent compatible with the materials temporary protected.

13.08.00. CONDENSATION PROTECTION:

The Employer and Contractor shall mutually agree on the products to be used.

13.09.00. SPARE PARTS:

The spare parts' surface coating shall be applied in compliance with the present specifications.

All temporary surface protections (until the spare parts are used) shall be designed to last for minimum 15 years/ or the period of storage of the parts specified in the ER.

13.10.00. COLOR OF THE FINISH COAT:

The Employer shall define the color of the finish coat**.**

14.00.00. PROTECTION THICKNESS:

Protection thickness shall be checked in compliance with the following specifications:

14.01.00. Number of Measurement Points :

The number of measurement points is defined in the following table:

Size of the surface to be tested (reference zone, in m^2 or in linear meter)	Number of measuring points recommended
< 10	10 to 20
10 to 100	20 to 50
100 to 1000	50 to 100
1000 to 10000	100 to 200

14.02.00. Tolerance on System Minimum Thickness:

Spot measurements less than the minimum thickness shall be accepted if both following conditions are fulfilled:

- the average of all the measurements performed on the reference zone is equal to or greater than the required minimum value, and

- no measurement point is less than 80% of the required minimum value.

In case of non-compliance with the criteria listed here above, the Contractor shall be obliged to touch up surface protection, either locally or completely.

The touch-up procedure shall be submitted to the Employer.

15.00.00. PRODUCT CHARACTERSTICS DATA SHEET:

For each product, the Contractor shall provide a characteristics data sheet specifying:

- the manufacturer's references,
- product characteristics,
- application conditions.

The Contractor shall submit a model data sheet to the Employer. This sheet shall then be used for all surface protection works.

16.00.00. PAINTING/ COATING QUALITY CONTROL SHEET:

During coating operations, the Contractor shall fill out the quality control sheet agreed upon by the Employer and the Contractor.

QA&I: Vishnugad-Pipalkoti HEP (4x111 MW)

Electrical Works

QA & I REQUIREMENTS: ELECTRICAL WORKS

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E8. L.T POWER CABLES (1.1 KV PVC & XLPE) (Pg. 1 of 3)

Item / Components / Sub System Assembly / Attributes / Characteristics	Make, Rating, Type & TC	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Hot set test (XLPE)	Lay length / Sequence	Armour coverage, Cross over, looseness, Gap between two armour wire/strip	Sequential marking/surface finish /cable length	Tensile strength, elongation before & after ageing of insulation & outer sheath	Thermal Stability of insulation and outer sheath *	Anti termite treatment on wooden drums	Constructional / requirement as per THDC Spec.	Routine and acceptance test as per Relevant Standard and THDC specification	FRLS Test
Aluminum (IS-8130)	Y	Y	Y	Y	Y											
PVC Compound (IS-5831)	Y		Y		Y						Y					
XLPE Compound (IS-7098 Part-I)	Y		Y		Y		Y				Y					
FRLS PVC Compound (IS-5831) ASTM-D-2843/ ASTM-D-2863 IEC-754 Part-I	Y		Y								Y					
Armour wire/strip (IS-3975)	Y	Y	Y													
Insulated Core		Y				Y	Y					Y				
Laid up core		Y						Y								
PVC Inner sheath		Y														
Armouring		Y							Y							
Outer sheath		Y								Y	Y	Y				Y
Finish cable (IS-1554 & 7098 – Part-1) ASTM-D-2843/ IS 10810 (Part- - 58) IEC-754 Part-I Swedish Chimney SS 4241475 for (F3 category) Flammability test IEC-332 Part –3 Cat-B	Y	Y							Y	Y	Y	Y		Y	Y	Y
Wooden drum (IS-10418) / Steel drum		Y											Y			

Note:

1. ***This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.***
2. **All major Bought Out Items will be subject to Owner's approval.**
3. **Any other tests mentioned in the equipment specification are also to be carried out.**
4. **4. The codes and standards mentioned in equipment specification is governing.**

ROUTINE TESTS : **Routine tests shall be carried out on each drum of finished cables for all types & sizes. Following shall constitute routine tests:**		
	Conductor Resistance test	
	High voltage test at room temperature	
ACCEPTANCE TESTS:		
	Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1 & IS 7098 Part-I	
A)	**For Conductor**	
1)	Annealing test	For copper conductor only
2)	Tensile test	For aluminium conductor only
3)	Wrapping test	For aluminium conductor only
4)	Resistance test	
B)	**For Armour Wires / Formed Wires (If applicable)**	
1)	Measurement of Dimensions	
2)	Tensile Tests	
3)	Elongation Test	
4)	Torsion Test	For Round wires only
5)	Wrapping Test	
6)	Resistance Test	
7)	Mass of Zinc coating test	For G S wires / Formed wires only
8)	Uniformity of Zinc coating	For G S wires / Formed wires only
9)	Adhesion test	For G S wires / Formed wires only
Freedom from defects		

E8. L.T POWER CABLES (1.1 KV PVC & XLPE) …. CONTD. (Pg. 3 of 3)	
C)	**For PVC / XLPE insulation & PVC Sheath**
1)	Test for thickness
2)	Hot set test For XLPE insulation only
3)	Tensile strength & Elongation before ageing
D)	**For completed cables**
1)	Insulation resistance test (Volume resistivity method)
2)	High voltage test **at room temperature**
E)	**Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-**
1)	Tensile strength & elongation after ageing **on PVC / XLPE insulation and PVC outer sheath**
2)	Thermal stability test **on PVC insulation and outer sheath**
3)	Oxygen index test **on outer sheath**
4)	Smoke density rating test **on outer sheath as per ASTM –D 2843**
5)	Acid gas generation test **on outer sheath as per IEC – 754 (Part 1)**
6)	Flammability test as per IEC-332 - Part- 3 (Category- B) **on completed cable**
7)	Fire resistance test as per SS 4241475 (F3 Category) **on completed cable**
F)	**Following tests shall be carried on one length of each size of offered lot:**
1)	Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires

E9. L.T CONTROL CABLES (1.1 KV PVC) (Pg. 1 of 3)

Attributes / Characteristics / Item / Components / Sub System Assembly	Make, Type, Rating, T.C	Dimension/surface finish	Mechanical Properties	Chemical Composition	Electrical Properties	Spark Test	Lay length/Sequence	Armour coverage, cross over, looseness, gap between two armour wire	Sequential marking/surface finish/cable length	Tensile strength, elongation before & after ageing of insulation &outer sheath sheath	Thermal stability of insulation and outer sheath	Anti termite treatment on wooden drums	Constructional feature as per THDC Spec.	Routine & Acceptance test as per relevant standard & page 2 & 3 of this table	FRLS Test
Copper Conductor (IS-8130)	Y	Y	Y	Y	Y										
PVC Compound (IS-5831)	Y		Y		Y					Y					
FRLS PVC Compound IS-5831ASTM-D-2843/ IS 10810 (Part-58) IEC-754 Part-1	Y		Y							Y					Y
Armour wire/strip (IS-3975)	Y	Y	Y												
Insulated Core		Y				Y	Y				Y				
Laid up core		Y					Y								
PVC Inner sheath		Y													
Armouring		Y						Y							
Outer sheath		Y							Y	Y	Y				Y
Finish cable (IS-1554- 1) ASTM-D-2843/ IS 10810 (Part-58) IEC-754 Part-1 Swedish Chimney: SEN SS 424-1475 (F3 category) Flammability test IEC-332 Part-3 Cat-B	Y	Y						Y	Y	Y	Y		Y	Y	Y
Wooden drum (IS : 10418) / Steel drum		Y										Y			

Note:

1. ***This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.***
2. **All major Bought Out Items will be subject to Owner's approval.**
3. **Any other tests mentioned in the equipment specification are also to be carried out.**
4. **The codes and standards mentioned in equipment specification is governing.**

ROUTINE TESTS

Routine tests shall be carried out on each drum of finished cables for all types & sizes.

Following shall constitute routine tests:

Conductor Resistance test

High voltage test at room temperature

ACCEPTANCE TESTS

Following Acceptance tests shall be carried out for each type and size of the cables on the cable drums selected at random as per sampling plan mentioned in IS: 1554 Part 1

A) For Conductor

1.	Annealing test	For copper conductor only
2.	Resistance test	

B) For Armour Wires / Formed Wires (If applicable)

1.	Measurement of Dimensions	
2.	Tensile Tests	
3.	Elongation Test	
4.	Torsion Test	For Round wires only
5.	Wrapping Test	
6.	Resistance Test	
7.	Mass of Zinc coating test	For G S wires / Formed wires only
8.	Uniformity of Zinc coating	For G S wires / Formed wires only
9.	Adhesion test	For G S wires / Formed wires only
10.	Freedom from defects	

C) For PVC insulation & PVC Sheath

1. Test for thickness

2. Tensile strength & Elongation before ageing

D) For completed cables

1. Insulation resistance test (Volume resistivity method)

2. High voltage test **at room temperature**

E) Following tests shall be carried out and only one sample shall be taken from each offered lot of all sizes for these tests:-

1. Tensile strength & elongation after ageing **on PVC insulation and PVC outer sheath**

2.Thermal stability test **on PVC insulation and outer sheath**

3.Oxygen index test **on outer sheath**

4.Smoke density rating test **on outer sheath as per ASTM –D 2843**

5.Acid gas generation test **on outer sheath as per IEC – 754 (Part 1)**

6.Flammability test as per IEC-332 - Part- 3 (Category- B) **on completed cable**

7.Fire resistance test as per SS 4241475 (F3 Category) **on completed cable**

F) Following tests shall be carried on one length of each size of offered lot:

1) Surface finish, length measurement, sequence of cores, armour coverage, Gap between two consecutive armour wires / formed wires

E.11. INDUCTION MOTOR & SYNCHRONOUS MACHINE (Pg 1 of 2)

TESTS/CHECKS / TEMS/COMPONENTS	Visual	Dimensional	Make/Type/Rating/TC/General Physical Inspection	Mech/ Chem. Properties	NDT /DP/MPI/UT	Metallographic	Electrical Characteristics	Welding/Brazing(WPS/PQR)	Heat Treatment
Plates for stator frame, end shield, spider etc.	Y	Y	Y	Y					Y
Shaft	Y	Y	Y	Y	Y	Y			Y
Magnetic Material	Y	Y	Y	Y	Y		Y		
Rotor Copper/Aluminum	Y	Y	Y	Y		Y	Y		Y
Stator copper	Y	Y	Y	Y			Y		Y
SC Ring	Y	Y	Y	Y	Y	Y	Y	Y	Y
Insulating Material	Y		Y	Y			Y		
Tubes for Cooler	Y	Y	Y	Y	Y				Y
Sleeve Bearing	Y	Y	Y	Y	Y				Y
Stator/Rotor, Exciter Coils	Y	Y	Y				Y	Y	
Castings, stator frame, terminal box and bearing housing etc.	Y	Y	Y	Y	Y			Y	
Fabrication & machining of stator, rotor, terminal box	Y	Y			Y				Y
Wound stator	Y	Y					Y	Y	
Wound Exciter	Y	Y					Y	Y	
Rotor complete	Y	Y					Y		
Exciter, Stator, Rotor, Terminal Box assembly	Y	Y					Y		
Accessories, RTD, BTD,CT, Brushes, Diodes,Space heater, antifriction bearing, cable glands, lugs, gaskets etc.	Y	Y	Y						
Motor (IS 325 / 4722/ 9283)	Y	Y	Y						

E11. **INDUCTION MOTOR & SYNCHRONOUS MACHINE** (Pg 2 of 2)

TESTS/CHECKS / ITEMS/COMPONENTS	Magnetic Characteristics	Hydraulic/Leak/Pressure Test	Thermal Characteristics	Run out	Dynamic Balancing	All tests as per IS-325/IS-4722 / 9283	Vibration	Over speed	Tan delta, shaft voltage & polarization index test
Plates for stator frame, end shield, spider etc.									
Shaft									
Magnetic Material	Y		Y						
Rotor Copper/Aluminum									
Stator copper			Y						
SC Ring									
Insulating Material			Y						
Tubes for Cooler		Y							
Sleeve Bearing		Y							
Stator/Rotor, Exciter Coils									
Castings, stator frame, terminal box and bearing housing etc.									
Fabrication & machining of stator, rotor, terminal box									
Wound stator									
Wound Exciter									
Rotor complete				Y	Y				
Exciter, Stator, Rotor, Terminal Box assembly									
Accessories, RTD, BTD,CT, Brushes, Diodes, Space heater, antifriction bearing, cable glands, lugs, gaskets etc.									
Motor (IS 325 / 4722 / 9283)						Y	Y	Y	Y1

Note**:**

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and procedure along with relevant supporting documents during QP finalization for all the items.
2. All major Bought Out Items will be subject to Owner's approval.
3. Any other tests mentioned in the equipment specification are also to be carried out.
4. The codes and standards mentioned in equipment specification is governing.

LT SWITCHGEAR (Pg 1 of 2)

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERIS-TICS → / ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per THDC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per THDC spec	All Routine tests as per THDC spec. & relevant std.
Sheet Steel (IS : 513)	Y	Y		Y	Y		Y							
Aluminum Bus bar Material (IS : 5082)	Y	Y	Y	Y	Y		Y							
Copper Bus bar Material (IS : 613)	Y	Y	Y	Y	Y		Y							
Support Insulator	Y	Y	Y	Y			Y							
Air Circuit Breaker (IS: 13947)	Y	Y				Y	Y			Y	Y			Y
Energy Meters (IS : 13010, 13779)	Y	Y				Y	Y			Y				Y
Power & Aux. Contactors (IS : 13947)	Y	Y				Y	Y			Y				
Protection & Aux. Relays	Y	Y				Y	Y			Y				Y
Control & Selector Switches (IS : 13947)	Y	Y				Y	Y			Y				
CT's & PT's (IS 2705 / 3156)	Y	Y					Y							Y
MCCB (IS : 13947)	Y	Y					Y			Y				
Indicating Meters (IS : 1248)	Y	Y				Y	Y			Y				Y
Indicating Lamps (IS : 13947)	Y	Y				Y	Y			Y				
Air Break Switches (IS : 13947)	Y	Y				Y	Y			Y				
Control Terminal Blocks	Y	Y				Y	Y							

LT SWITCHGEAR (Pg 2 of 2)

(MCC, PCC, ACDB, DCDB, FUSE BOARDS, LOCAL PUSH BUTTON STATION, LOCAL MOTOR STARTERS)

ATTRIBUTES / CHARACTERIS-TICS → / ITEMS/ COMPONENTS/ SUB SYSTEM ASSEMBLIY ↓	Make, Model, Type, Rating & TC	Dimensions & Finish	Electrical properties	Mechanical Properties	Chemical properties	Functional & Operational Features as per THDC Spec.	Item to conform to relevant Standards	Pretreatment as per IS 6005	Paint Shade, Adhesion, Thickness & Finish	Functional Checks	Milli-volt drop Test	IR – HV – IR Test	Degree of Protection Routine test as per THDC spec	All Routine tests as per THDC spec. & relevant std.
Fuse (IS 13703)	Y	Y				Y	Y							
Control Transformer (IS : 12021)	Y	Y				Y	Y			Y				Y
Push Buttons (IS : 4794)	Y	Y				Y	Y			Y				
Transducer (IEC : 60688)	Y	Y				Y	Y			Y				Y
MCB (IS : 8828)	Y	Y				Y	Y			Y				
Breaker Handling Trolley	Y	Y				Y			Y	Y				Y
Synthetic Rubber Gasket (IS : 11149)	Y	Y		Y	Y		Y							
LT SWITCHGEAR (IS : 8623)	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. Makes of all major Bought Out Items will be subject to THDC approval.

DC SYSTEM

A. LEAD ACID BATTERY								
ATTRIBUTES / CHARACTERISTICS → **↓ ITEMS, COMPONENTS, SUB SYSTEM ASSEMBLY**	Dimensions & Finish	Conformance to relevant part drg. & Manufacturer's standards	Chemical composition	Lead Coating Thickness (min. 25 microns, IS: 6848 App.F) & Adhesion Check	Conformance to CPWD Spec. for Steel Rack.	Paint Process checks, Paint Shade, Thickness, Adhesion & Finish	Constructional requirements as per THDC Spec.	Routine & acceptance tests as per relevant standard
Container & Lids (IS : 1146)	Y	Y						
Vent Plugs	Y	Y						
Sealing Compound (IS : 3116)		Y	Y					
Positive & Negative Plates		Y	Y					
Separators (IS : 6071)	Y	Y						
Electrolyte (Water /Sulphuric Acid) (IS : 1069 / 266)		Y	Y					
Inter-cell Connectors & Fasteners	Y	Y		Y				
Battery Stand	Y	Y			Y	Y		
Cell Insulators	Y	Y						
Stack Assembly	Y	Y						
Lead Acid Battery (IS : 1652)	Y						Y	Y

Note: This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

DC SYSTEM : BATTERY CHARGER														pg.2 of 3
Attributes / Characteristics → **Items / Components / Sub- assembly** ↓	Make, Model, Type, Rating & Finish	Verification of Routine test reports as per relevant IS	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard & THDC spec	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per THDC approved drgs & specification	Temperature Rise Test on one unit of each rating if Type testing is waived off	Ripple Content Test, Load Limiter & AVR Operation Test	Dynamic Response Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs in energised condition	Alternating current measurement test	Degree of Protection Test as per THDC Spec.
Rectifier Transformer and Reactors IS : 4540, 2026)	Y	Y		Y			Y				Y			
Electronic Components including Potentiometer (Vernier Type)	Y			Y		Y								
Electronic Cards	Y			Y								Y		
PCB & racks for electronic cards	Y					Y								
Control & Selector Switches (IS : 6875)	Y			Y						Y				
Indicating Meters (IS : 1248)	Y			Y						Y				
Indicating Lamps (IS: 13947)	Y			Y						Y				
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y				
Control Terminal Blocks (IS : 13947)	Y			Y										
Control Transformer (IS:12021)	Y			Y						Y				
Push Buttons (IS : 4794)	Y			Y						Y				
MCB (IS : 8828)	Y			Y						Y				
PVC insulated Copper control wires (IS : 694)	Y			Y										
Sheet Steel (IS : 513)	Y		Y	Y										
Synthetic Rubber Gaskets	Y			Y										
Annunciator	Y									Y		Y		
Battery Charger	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Notes: 1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents. 2.Makes of all major Bought Out Items will be subject to THDC approval.														

DC SYSTEM : **BATTERY CHARGER**

(of capacity upto 24 V / 48 V , 150 A DC) pg. 3of3

Attributes / Characteristics → / **Items / Components / Sub- assembly** ↓	Make, Model, Type, Rating	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features as per approved drgs	Ripple Content Test, Load Limiter operation & AVR Operation Test	Operational & Functional Checks of aux. Devices like annunciator, switches, indiactors etc.	HV & IR Test	Burn-In Test	Dynamic response test	AC input current measurement test	Temperature rise test on one unit
Battery Charger	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents
2. Makes of all major Bought Out Items will be subject to THDC approval.

CONTROL PANEL

Attributes Characteristics / Item Components Sub System Assembly	Electrical Properties	Mechanical Properties	Chemical Properties	Dimensions / Finish	Type/ Rating/Functional check	HV/IR	Routine test as per relevant std.	Constructional Features	IS:6005 ,Seven tank process	Paint finish/ shade/thickness adhesion	Mountings / BOM/ Make, Completeness	Interlock Functional & Operation Testing / Simulation check	Degree of Protection Test	Specification requirement
Sheet Steel (IS-513)		Y	Y	Y										
Aluminum / Copper Bus-bar(IS-5082/IS-613/IS-1987)	Y	Y	Y	Y										
Support Insulator (BS-2782/IEC-660/IS-10912)	Y	Y	Y	Y										
Control / Selector Switch (IS-6875)					Y	Y	Y							
Contractor/ MCB (IS-13947)					Y	Y	Y							
O/L Protection relays (IS-3231)					Y		Y							
C.T /V.T/ Indicating Meter (IS-2705/3156/1248)					Y	Y	Y							
Fuse/ Fuse carrier(IS-13703)					Y	Y	Y							
Terminals/lugs/pvc wires (IS-13947//IS-694)	Y			Y	Y	Y	Y							
Timers(IS-3231)					Y	Y	Y							
LVS, Mosaics														Y
Push Button/ Lamp/ (IS-6875)					Y	Y	Y							
Control Transformer (IS-12021)					Y	Y	Y							
Mimic, Annunciater					Y		Y							
GASKET (IS-11149)		Y	Y	Y	Y		Y							
Fabrication								Y						
Pretreatment & Painting									Y	Y				
Control panel										Y	Y	Y	Y	Y

NOTE:

1. This is an indicative list of Test/ Checks. The manufacturer to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.
2. All major Bought out Items will be subject to OWNER approval.
3. Any other tests mentioned else where in technical specification are also to be carried out. The codes and standards mentioned in Technical specification is governing

CABLING, EARTHING, LIGHTNING PROTECTION

ATTRIBUTES / CHARACTERISTICS / ITEMS/COMPONENTS / SUB SYSTEMS	Dimension	Paint shade, paint thickness, adhesion	Pre-treatment of sheet	IP protection	Proof load*	Surface finish	Deflection test*	HV & IR	Galvanize Test (If Applicable)	Functional	Bought out items/Bill of material	Routine tests as per relevant standard & specification	Acceptance tests as per relevant standard & specification	Constructional feature as per THDC Specification
Wall Mounted-Lighting Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Switch box/junction box/ Receptacles Panel (IS-513, IS:5, IS:2629, 2633, 6745)	Y	Y	Y	Y		Y		Y	Y	Y	Y	Y	Y	Y
Cable glands(BS-6121)	Y											Y		
Cable lug(IS-8309)	Y											Y		
Lighting wire(IS-694)	Y											Y		
Flexible conduits	Y											Y		Y
Conduits(Galvanise & Epoxy) IS-9537 & IS-2629,2633 ,6745	Y		Y								Y	Y		Y
RCC Hume Pipe (IS-458)												Y		
Cable termination & straight through joint (VDE-0278)	Y											Y		Y
Cable Trays, Flexible supports system & accessories IS-513, 2629,2633,6745	Y		Y		Y	Y	Y	Y	Y	Y		Y	Y	Y
Trefoil clamp	Y													Y
GI flats for earthing & lighting protection (IS 2062, 2629, 6745,2633)	Y		Y						Y			Y		Y
GI wire (IS-280)	Y											Y		
Fire Sealing System (BS –476)												Y	Y	Y

Note:1.This is an indicative list of tests /checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2.* Deflection Test on cable trays and Proof Load test on cable trays support system will be as per details given in the THDC technical specification & approved MQP. The above acceptance tests shall be done only on one sample from each size of offered lot.

3. Make of all items will be subject to OWNER's approval.)

4. Any other tests mentioned else where in technical specification are also to be carried out. The codes and standards mentioned in Technical specification is governing

Control
&
Instrumentation Works

QA& I REQUIREMENTS: C&I WORKS

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1	Control & Instrumentation (C&I) – General Requirements	126 – 131
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1.00.00 REQUIREMENTS OF AUTHORISATION-TO-SHIP-TEST (ATST) FOR SCADA

1.01.00 Authorization-to-ship-test (ATST) or Factory acceptance test (FAT) shall include all required tests to fully demonstrate to Employer's satisfaction that each equipment/sub-system/system as well as software modules furnished as per this specification as well as SCADA as a whole, fully meets the functional, parametric and other requirements of this specification and Employer's approved drawings/documents under all operating regimes. The parametric requirements shall be as per SCADA specifications. All tests pertaining to Control System shall be applicable.

Contractor to note that ATST procedure given below in subsequent clauses are only indicative in order to help the Contractor in understanding the requirements and help him in submitting a detailed procedure based on these guidelines meeting all the specification requirements. These requirements are in addition to those stipulated against SCADA integrated testing.

1.01.01 The Authorisation-To-Ship-Test (ATST) shall include all reasonable exercises which the combination of equipment and software can be expected to perform. These tests shall be divided into, as a minimum, but not limited to the following categories:

(a.) Pre power on checks
(b.) Power on check
(c.) Hardware tests
(d.) Functional tests
(e.) Parametric tests
(f.) Power failure auto-restart tests

1.01.02 Pre power on checks

These tests shall include but not be limited to the following:

(a.) Visual Checks:
These tests will include checking of individual cubicles, peripherals, etc. for damages; proper inspection of cubicles, internal cabling, tuning, door arrangements, louvers, fans etc.

(b.) Hardware verification:
These tests will include verification of location of each card and module in Control System, HMIPIS, master clock systems, etc. Verification of no. of modules as per the approved BOM and corresponding layout drgs. on sub system basis. Verification of spare capacity in the cubicle for installation of new modules.

(c.) Verification of system technical documentation as per approved list.

1.01.03 Power on check

To observe the start up and automatic loading initialization of software when system is energised.

1.01.04 Hardware tests

These tests shall include but not be limited to the following tests:

(a.) Verification of healthiness of all modules e.g., I/O modules, controller modules, processors, peripherals, etc.

(b.) System configuration:

(1.) Verification of system configuration with reference to approved configuration diagrams, communication controller, I/O redundancy, verification of multiple measurement scheme, HMIPIS configuration, etc.

(2.) Verification of features of complete SCADA like on line removal of I/O and controller modules, etc. in line with specification requirements.

(c.) Simulation of inputs:

To verify conversion calculations, scan rates, operator's functions, corrections of calculations. For simulation of inputs for I/O modules, this test will be carried out for 10% of each type of modules or min. 1 no. of each type, whichever is more.

(d.) Accuracy test:

Accuracy for analog inputs/ output shall be demonstrated for one of each type of analog card.

(e.) Demonstration of the manual and auto switchover from master to standby system bus, controllers, I/Os, processors etc.

(f.) Diagnostics Tests:

Complete on-line diagnostic tests on HMIPIS, individual peripherals, Control System, programmer stations, etc.

1.01.05 Functional Tests

The following tests shall be carried out on Contractor's SCADA.

(a.) Functional tests of CLCS:

(1.) Verification of proper signal acquisition, conditioning and distribution.

(2.) Verification of proper realisation of controller functions like bumpless transfer from auto to manual and vice versa (as stated above), functional checking of bias circuit (wherever provided), etc.

(b.) Functional tests of OLCS:

(1.) Verification of proper signal acquisition, conditioning and distribution.

(2.) Verification of proper realisation of logic functions, sequence control functions, running of complete start up program sequence in all modes of operation, shut down program, etc.

(3.) Verification of logic computation in controller by simulating inputs.

(c.) Functional tests for HMIPIS

(1.) Verification of all types of displays, logs including their formats, bar graphs, X-Y plots etc. Verification of all function keys on keyboards and availability of all operator functions.

(2.) Verification of event generation and handling capabilities of HMIPIS processors by simulating various types of events/data and observing associated event sequence display and alarm signalling boxes.

(3.) Calculations:

All calculations shall be tested on sample basis to demonstrate that these are in accordance with the specification and Employer's input as applicable. The Contractor shall prepare tests cases for calculations for proper verification for the features required for each type of computations.

(4.) Checking historical storage and retrieval functions including long term storage.

(5.) Verification of all programmer's stations functions for HMIPIS and Control System, as well as for documentation facility as specified.

(6.) For SER function, verification of resolution of SOE inputs, time synchronisation with master clock, data base modification, SOE report, printout, off-line & on line diagnostic features etc. For this purpose a test-simulator to generate sequences of 1 ms resolution for 100 points distributed in different panels shall be made available during testing.

(7.) Testing of each peripheral viz., CRTs, printers, hard disk drive, floppy drive, etc.

(8.) Testing of power supply system to SCADA, tolerance of SCADA w.r.t. voltage & frequency limits as specified, performance of SCADA with power supply break as specified .

(9.) Verification of switchover of main processor/controller to stand by processor/controller.

(10.) Verification of spare capacity w.r.t. spare wired-in space in cabinets/ cubicles, terminal blocks, peripherals, etc. in line with spec. requirements as stipulated under scope of work.

1.01.06 Parametric tests

Following tests shall be carried out to test Contractor's SCADA w.r.t. specification requirements.

(a.) For control system :
- (1.) CPU loading
- (2.) Cycle time/controller reaction time.
- (3.) Memory spare capacity

(b.) For HMIPIS
- (1.) CPU loading
- (2.) Spare duty cycle
- (3.) Spare memory capacity

(c.) Spare duty cycle for system bus

(d.) Various display response time

(e.) System accuracy

(f.) Demonstration of system reliability

(g.) Display update time on OWS CRT/LVS

1.01.07 Power failure auto restart test

Verification of availability of all system functions automatically after restoration of power after power failure to SCADA. Verification of restoration of all data which was stored in the system at the time of power loss.

1.01.08 The Contractor shall submit a detailed ATST procedure for Employer's approval during detailed engineering stage based on the above guidelines. The ATST procedure to be submitted by the Contractor shall be detailed and exhaustive enough such that Employer is satisfied that all the SCADA System specification requirements and features are being tested and the system meets these requirements. The test results obtained shall be properly documented by the Contractor and furnished in the Employer approved format as decided during detailed engg. And submitted in the requisite no. of copies with all annexures irrespective of the fact that Employer's representative was present during the tests.

1.01.09 The following minimum criteria shall be followed during all tests:

1.02.00 Integrated Test Set-Up

For integrated testing of the total SCADA system, the Contractor shall employ a test set up PC based I/O simulator, which will capable of I/O signals in requisite manner. It is preferable to adopt soft signal simulating device to avoid cumbersome process of physical connection of I/O through potentiometer, switches, Lamps/LED's etc. The exact configuration/ set up shall be as finalized during detailed engineering.

1.02.01 System shall meet all parametric and functional requirements of tech. specification.

1.02.02 Any allowable operator inputs through key-boards shall not result in system crash or hanging.

1.02.03 Disconnection/ failure of HMIPIS shall not result in loss of any control function.

1.02.04 Pulling out or insertion of any I/O module online from its slot, shall not result in any subsystem failure.

1.02.05 The Contractor is to submit Authorisation-To-Ship-Test (ATST) procedure as a part of "Draft QA Programme fully meeting the intent and requirements of above and other applicable clauses of this specification. Since, the exact definition & extent / parameters of ATST can be finalised only when the engineering of SCADA has been finalised to a great extent, it is required that the detailed draft ATST procedure be submitted by the Contractor at a later date as intimated by the Employer during engineering stage for Employer's comment and finalisation. Contractor shall incorporate all modifications, additions/ deletions to the ATST procedure as indicated by the Employer. The ATST shall be conducted as per Employer approved procedure for ATST which will be included in the approved "QA Programme". The Employer reserves the right to ask the Contractor to conduct any other test also during the ATST which may be required to fully satisfy the Employer regarding full compliance with specification requirements. Contractor shall conduct all such tests also within the quoted lump sum price for this contract.

1.02.06 The results of all ATS Tests shall be properly documented by the Contractor and submitted to Employer in requisite number of copies with all annexures.

1.02.07 Following the tests, if in the opinion of the Employer, the system has not been adequately manufactured, programmed, tested or debugged the Contractor shall make good all deficiencies including system parametric specifications of display response time, processor duty cycle, SOE resolution, etc., and re-run the test to fully satisfy the Employer regarding full compliance with specification requirements and requisite quality standards.

1.02.08 The system shall not be shipped without approval of Employer in writing.

1.02.09 Upon successful completion of Authorisation-To-Ship Test, the Employer will provide the Contractor with a written Authorisation for shipment of the system equipment to the project site.

1.02.10 All final documentation as per requirement of this specification shall be available at the time of Authorisation-To-Ship-Test and this shall be dispatched alongwith the equipment in required number of copies.

1.02.11 Contractor shall note that no payments towards dispatch of equipment and subsequent activities shall be due and payable to the Contractor till the Contractor is able to successfully demonstrate to Employer's satisfaction that the SCADA and parts thereof fully meet the Authorisation-To-Ship-Test requirements.

CONTROL DESK, PLC PANEL, SMOKE DETECTOR, FIRE ALARM CONTROL PANEL

ITEMS \ TESTS	Visual ®	GA, BOM ,Lay Out of components ®	Dimensions ®	Paint Shade/Thickness/Adhesion ®	Alignment of Section ®	Component Rating/ Make / Type ®	Wiring ®	IR & HV ®	Review of TC for instruments/ Devices/ Recorders, Indicators/ osaic Items/ Transducers ®	Accessibility of TBS/ Devices ®	Illumination ®	Functional Check for Control Element, Annunciation ®	Mimic ®	Test as per IEC 1131 ® *	Test as per Std ® & (A)
1. Annunciation, Control, PLC Panel, Fire alarm panel	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y			Y	Y
2. Smoke Detectors (UL-268,EN-54 PT-7), Heat Detectors (UL-521/ EN 54 PT-5) Annunciation/ Control Panel (UL -864, EN-54, PT-2)															Y

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements

2) This is an indicative list of test/ checks. The manufacturer is to furnish a detailed quality plan indicating the Practice and Procedure alongwith relevant supporting documents.

- *Applicable for PLC
- Y - Test Applicable , ® - Routine Test (A) - Acceptance Test

BATTARY CHARGER

Attributes / Characteristics → / Items / Components / Sub- assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of Battery Charger as per THDC specification	Temperature Rise Test	Dynamic Response Test	Ripple Content Test, Load Limiter & Annunciator & AVR Operation Test	Operational & Functional Checks	HV & IR Test	Burn-In Test at 50^C for 48 hrs	Degree of Protection Test as per THDC Spec.
Rectifier Transformer (IS : 2026)	Y			Y			Y				Y		
Electronic Components including Potentiometer (Vernier Type)	Y			Y									
PCB & Electronic Cards	Y			Y									
19" standard racks for electronic cards	Y					Y							
Control & Selector Switches (IS : 6875)	Y			Y						Y			
Indicating Meters (IS : 1248)	Y			Y						Y			
Indicating Lamps (IS: 13947)	Y			Y						Y			
Air Break Switches / Fuses (IS : 13947 / 13703)	Y			Y						Y			
Control Terminal Blocks(IS :13947)	Y			Y									
Control Transformer (IS : 12021)	Y			Y						Y			
Push Buttons (IS : 4794)	Y			Y						Y			
MCB (IS : 8828)	Y			Y						Y			
PVC insulated Copper control wires (IS : 694)	Y			Y									
Sheet Steel (IS : 513)	Y	Y	Y	Y									
Synthetic Rubber Gaskets	Y	Y		Y									
Annunciator	Y									Y		Y	
Battery Charger	Y				Y	Y	Y	Y	Y		Y	Y	Y

Notes:1.Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements

2.This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the Practice and procedure along with relevant supporting documents.

3. Makes of all major Bought Out Items will be subject to THDC approval.

POWER SUPPLY SYSTEM																	
TESTS / ITEMS	Visual/dimension/rating/ Paint Adhesion/ Thickness (R)	General arrangement/BOM/make of components /Mimic ®	Efficiency ,regulation(R)	Input voltage variation (A)	Out put voltage and frequency adj.range(A)	Premilinary light load test(R)	Load transfer retransfer test (R) *	AC input faliure and return test (R)	Parralel operation and current divison(R)	Relative harmonic content(R)	Restart with PRI A.C and battery (separately)(R)	System transfer and retransfer (R)*	Asynchronous transfer(R)	Ripple content(R)	Load limiter operation (R)	IR/HV(R)	Tests as per standard &specification (R)&(A)
UPS/CONVERTER (IEC-146 PT-4)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
VOLTAGE STABILISER	Y	Y	Y	Y	Y					Y		Y				Y	
LEAD ACID BATTERY(TUBLA)-IS-1651																	Y
LEAD ACID BATTERY (PLANTE)-IS-1652																	Y
NICKEL CADMIUM BATTERY(IS-10918/IEC-623)																	Y
R-Routine Test			A- Acceptance Test										Y – Test applicable				

* Transfer time and Over shoot /under shoot during load & system transfer shall be recorded .

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

INSTRUMENTATION CABLE

TESTS / ITEMS	Conductor Resistance ® & (A)	High Voltage ® & (A)	Insulation Resistance ® & (A)	Constructional detail, dimensions (A)	Outer-Sheathe/core marking, end sealing (A)	Thermal Stability (A) +	Visual, Surface finish (A) +	Electrical Parameters ** (A) +	Persulphate Test (A) +	Overall/Coverage/Continuity (A)	Swidesh chimney Test (SS-4241475) (A) ++	FRLS Test * (A) ++	Tensile & Elongation before & after aging (A)	Vol. Resistivity. at room & Elevated Temp. (A)	Spark test report review ®
1. Instrument cable twisted and shielded															
Conductor(IS-8130)	Y			Y			Y								
Insulation(VDE-207)				Y	Y	Y	Y						Y		Y
Pairing/Twisting				Y	Y		Y								
Shielding				Y			Y			Y					
Drain wire	Y			Y			Y		Y	Y					
Inner Sheath				Y	Y	Y	Y					Y	Y		
Outer Sheath				Y	Y	Y	Y					Y	Y		
Over all cable	Y	Y	Y	Y	Y		Y	Y			Y			Y	
Cable Drums(IS-10418)				Y			Y								

Note : High Temp. cables shall be subjected to tests as per VDE-207 (Part-6) Compensating cables shall be checked for Thermal EMF/Endurance test as per IS 8784.

Note : This is an indicative list of tests/checks. The manufacture is to furnish a detailed Quality Plan indicating his practice & Procedure along with relevant supporting documents during QP finalization for all item.

Note : ® - Routine Test A - Acceptance Test Y - Test Applicable

Note : Sampling Plan for Acceptance test shall be as per IS 8784 (As applicable)

- * FRLS Tests: Oxygen / Temp Index (ASTM D-2863), Smoke Density Rating (ASTM – D 2843), HCL Emission (IEC-754-1)
- ** Characteristic Impedence, Attenuation, Mutual Capacitance, Cross Talk (As applicable)

\+ Sample size will be One No. of each size/type per lot.

++ Sample size will be One No. sample for complete lot offered irrespective of size/type.

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY) pg1of2						
TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Test as per standard(R)	Insulation Resistance (R)
1. PR Gauge (IS-3624)	Y	Y	Y	Y	Y	
2. Temp. Gauge (BS-5235)	Y	Y	Y	Y	Y	
3. Pr./D.P.Switch (BS-6134)	Y	Y	Y	Y	Y	Y
4.Electronic Transmitter (IEC-770)	Y	Y	Y	Y	Y	Y
5. Temp. Switch	Y	Y	Y	Y	Y	Y
6. Recorder (IS-9319/ANSI C-39.4)	Y	Y	Y	Y	Y	Y
7. Vertical indicators	Y	Y	Y	Y		Y
8. Digital Indicators	Y	Y	Y	Y		Y
9. Integrators	Y	Y	Y	Y		
10. Electrical Metering Instrument (IS-1248)	Y	Y	Y	Y	Y	Y
11. Transducer (IEC-688)	Y	Y	Y	Y	Y	Y
12. Thermocouples (ANSI-MC-96.1)	Y	Y	Y	Y	Y	Y
13. RTD (IEC-751)	Y	Y	Y	Y	Y	Y
R-Routine Test A- Acceptance Test Y – Test applicable						

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

MEASURING INSTRUMENTS (PRIMARY AND SECONDARY

TESTS / ITEMS	Dimensions (R)	Make, Model, Type, Rating (R)	Process / Electrical connection (R)	Calibration (R)	Requirement as per standard (R)	WPS approval (A)	Non-destructive testing (R)	Insulation Resistance (R)	IBR Certification as applicable (R)	Hydro test (R)	Material test certificate (A)
14. Thermowell									Y	Y	Y
15. Cold junction compensation box	Y	Y	Y	Y				Y			
16. Orifice plate (BS-1042)	Y	Y	Y	Y*	Y	Y**	Y**		Y	Y**	Y
17. Flow nozzle (BS-1042)	Y	Y	Y	Y*	Y	Y	Y		Y	Y	Y
18. Level transmitter/ switch	Y	Y	Y	Y				Y	Y	Y	Y
*Calibration to be carried out on one flow element of each type and size if calibration carried out as type test same shall not be repeated.											
** If applicable											

R-Routine Test A- Acceptance Test Y – Test applicable

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Conditions

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the Practices and Procedure adopted alongwith relevant supporting documents.

ELECTRICAL ACTUATOR WITH INTEGRAL STARTER

Test/Attributes / Characteristics / ITEM/ COMPONENT/ SUB SYSTEM ASSEMBLY/ TESTING	RPM ®	No Load Current ®	IR & HV Test®	Mounting Dimension®	All routine Test as per Standard & Specification®	Correct Phase Sequence®	Operation & Setting of limit Switch/Torque Switch®	Stall Torque/Current (A)	Hand Wheel operation/ Auto de clutch function (A)	Function of Aux. like Potentiometer, space heater, position indicator ®	EPT output ®	Grease leakage ®	Local/ Remote (Open-Stop-Close) Operation® Safety check (Single phasing, Phase correction, Tripping etc.) (A)
ELECTRICAL ACTUATOR WITH INTEGRAL STARTER (IS-9334)													
Motor	Y	Y	Y	Y	Y								
Final Testing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: 1) Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements

2) This is an indicative list of tests/checks. The manufacturer is to furnish a detailed quality plan indicating the practices and procedure adopted along with relevant supporting documents.

® - Routine Test (A) - Acceptance Test Y - Test applicable

MAINTENANCE AND CALIBRATION EQUIPMENT				
Test/Attributes Characteristics / Item	`Make, Model, Type and Rating ®	Functional check®	Temp Stability Test (A)	Calibration®
Maintenance Calibration equipment				
Electronic test bench	Y	Y		Y
Dead Weight tester	Y	Y		Y
Vacuum tester	Y	Y		Y
Hydraulic Pressure gauge Tester	Y	Y		Y
Portable Pressure calibrator	Y	Y		Y
Secondary standard quality pressure Gauge	Y	Y		Y
Portable Electro Pneumatic Calibrator	Y	Y		Y
Portable Millivolt calibrator	Y	Y		Y
Resistance Thermometer Bridge	Y	Y		Y
Decade Resistance Box	Y	Y		Y
Portable thermocouple/RTD Calibrator/Simulator	Y	Y		Y
Portable Multifunction Counter	Y	Y		Y
Power pack	Y	Y		Y
RCL Bridge	Y	Y		Y
Portable Infrared Thermometer	Y	Y		Y

® Routine Test, (A) Acceptance Test, Y - Test applicable

Note:

1. Detailed procedure of Burn-in and Elevated Temperature test shall be as per Quality Assurance Programme in General Technical Requirements
2. This is an indicative list of tests/checks. The manufacturer is to furnish a check lists for final inspection indicating the practices and procedure adopted along with relevant supplying documents.
3. Other Maintenance & Calibration equipment shall be checked for functional and calibration (as applicable).
4. Calibration to be done with the instrument having better accuracy than the item under test and whose calibration shall be traceable to International Standard.

Mechanical Works

VISHNUGAD-PIPALKOTI HEP (4x111 MW)

QA&I REQUIREMENTS: MECHANICAL WORKS

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MATERIAL PROCUREMENT AND MANUFACTURE

1.00.0. SCOPE

This specification concerns the procurement materials and parts manufacturing methods (cutting, welding, etc.)

The minimum testing required from the Contractor is defined in the Appendix1.

1.01.0. MATERIALPROCURMENT

1.01.01 PROCUREMENT SPECIFICATIONS

The contractor shall submit material procure procedure.

For each part, the Contractor shall define the grade of materials and chemical composition compliance with the functions of the part and compatible with manufacturing conditions, unless specified in each detailed specification.

The Contractor shall provide the materials in compliance with the following standards:

Material	standard
Sheets	EN ,IS or equivalent
forging	EN, ASTM,IS or equivalent
casting	EN, ASTM, IS or equivalent

The following minimum thickness, unless otherwise specified, shall be observed for elements made of structural steels.

- Steel plate, flats: 8 mm
- Steel bar and sections, tubes: 6mm
- Embedded steel elements: 10mm

2.00.00. PROCUREMENT CONDITIONS

2.01.00. TESTS

The compulsory tests to be implemented (mechanical properties, inspections, etc.) shall be defined by the Contractor in a procurement specification in the form of a table indicating the type of tests to be performed, unless indicated detailed technical specifications.

2.02.00. FINAL DOCUMENTS

The identification of a part or product shall be ensured by individual marking. Traceability between the part or product and the acceptance inspection and test reports shall be ensured either individually or by batch, depending on stipulated acceptance conditions.

2.03.00. SUPPORTING DOCUMENTS FOR CHOICE OF MATERIALS

The contractor shall provide full technical support for his choice of materials for component procurement.

This support shall be based on analysis of all relevant data taken into account by the Contractor, in particular concerning design (dimension of parts), characteristics of the grades chosen, conditions for their treatment and implementation and equipment operating conditions.

3.00.00 MATERIAL INSPECTION

3.01.00. CHEMICAL COMPOSITION

The Contractor shall provide a description of the chemical composition specified and guaranteed for casting, forging and rolled products.

The Contractor shall provide chemical analysis of materials other than steel according to its classification of materials.

3.02.00. MANUFACTURING

3.02.01. Technical Manufacturing Programme

The Contractor shall specify the required technical manufacturing programme.

3.02.02. Delivery condition - heat treatment

The Contractor shall specify the delivery condition required for parts or products (thermally treated condition, pickling or aestivation operations, etc.)

The final quality heat treatment conditions shall be specified, in particular with the parameters of the cycles for this heat treatment, along with the instructions concerning temperature control.

3.03.00. MECHANICAL CHARACTERISTICS

3.03.01. Required Mechanical Characteristics

The Contractor shall list the mechanical characteristics specified and guaranteed, along with those also requested for information (including, if applicable, characteristics).

3.03.02. Instructions for taking samples

The Contractor shall specify the conditions under which samples shall be taken (condition of part or product, sample marking, etc) as well as the sampling procedures.

3.03.03. Tests to be performed:

The Contractor shall specify:

- Batch definition,
- Number and type of series of tests to be performed per batch,
- Test performance procedures,
- The conditions allowing parts or products to be reworked, specifying the amount of reworking authorized.

3.04.00. Non-Destructive Tests

The non-destructive tests shall be achieved in compliance with the following standards:

Material	ND test
sheets, rolled products	EN 10160(#) or equivalent
forging	See Appendix-II
casting	CCH -70-3

(#): EN 10160 "Ultrasonic Testing of steel flat product of thickness equal or greater than 6 mm" (Dec-1999)

3.05.00. VISUAL INSPECTION

The contractor shall specify a procedure of visual inspection in accordance with admitted standard (ASME or equivalent) performed on the parts or products, with the scope of these tests and their associated acceptance criteria.

4.00.00. MANUFACTURE

4.01.00. IDENTIFICATION AND MARKING OF PRODUCTS AND PARTS

Products and parts to be used shall be marked for identification (e.g. equipped with permanent identification plates in readily visible locations). The inscription shall be printed, punched or engraved, and water-proof, oil-proof, and wear-resistant.

Equipment manufacture may begin only of the base materials to be used have been identified

The identification plates shall be protected during erection and especially during painting. Damaged identification plates shall be replaced by new ones.

Marking shall be performed in such a way that it shall not affect the materials behavior under normal operating conditions.

5.00.00. MANUFACTURING

5.01.00. CUTTING

Mechanical or thermal cutting shall be used to achieve the required size. Eliminating the zone hardened by mechanical or thermal cutting shall not be required, if this zones either melted or restored during welding.

The contractor shall examine the need to preheat prior to thermal cutting, according to grade of steel and thickness.

5.02.00. ASSEMBLY

The Contractor shall verify, by preliminary tests or by applying the rules set out in engineering codes, that the parts mechanical characteristics (tensile strength, elongation, impact strength) have not been deteriorated by forming. if this cannot be proven conditioning heat treatment shall be applied.

5.02.01. Welding:

All welds shall comply in all respect with ASME or EN standard.

5.02.02. Mechanical Assembly:

All mechanical assembly operations shall be described in a procedure specifying:

- The type of lubricant used,
- The required tightening torque or elongation value
- The required tightening sequence and type of tools.
- Alignment tolerance,
- Functional clearances
- The related dimensional inspections

The lubricants used shall be stable at operating temperature and compatible with the materials with which they are in contact.

If manufacture in operations are likely to bring foreign materials into tapped bore holes, the latter shall be plugged for protection.

6.00.00. SURFACE TREATMENT:

The Contractor shall respect the Gen. Tech. Requirements "Surface Treatment and Coatings" (see Annexure-A of B-QA&I Requirement for EM Equipment).

7.00.00. HYDROSTATIC TEST

Unless otherwise specified in TS, the Contractor shall undergo the following procedure:

Equipment under pressure shall undergo hydrostatic testing in the factory, except where previously agreed otherwise by the Contractor and the Employer.

Testing temperature shall be the normal operating temperature, and test pressure shall be 1.5 times the rated pressure or where there is a written waiver in the particular specifications.

The test shall last long enough to allow complete inspection of the parts under pressure. A hydrostatic test shall be considered satisfactory if neither leakage during testing nor significant permanent deformation after testing have been observed, with a minimum test time of 30 minutes. However, it may be necessary to increase test time for large thicknesses.

The Contractor shall prepare a report for every hydrostatic test.
All pressure and tightness tests shall be performed prior to surface treatment.

8.00.00. CLEANLINESS

During manufacturing, the Contractor shall take all the necessary measures to ensure that equipment is not contaminated by chemical products harmful to its withstand overtime.

Before packaging for shipping, equipment cleanliness shall be inspected according to the criteria defined above-mentioned. This cleanliness inspection shall be recorded in a report specifying the equipment, the inspection performed, and inspection results. If necessary, the equipment shall be re-cleaned and shall undergo a second cleanliness inspection before shipping.

9.00.00. Electrical items

Electrical items like motors, control panels, cables, resistances, switches, other control & protection devices shall be tested as per relevant IS Standards for their electrical characteristics.

APPENDIX-I

CHART OF REQUIRED TESTS

The **minimum** testing required from the Contractor is defined in the charts hereafter.

This document of required tests shall be confirmed and submitted by the Contractor to the Employer.

Meaning of symbols used in the chart

C : Part or element manufactured by casting

W: Part or element manufactured by welding

F : Part or element manufactured by forging

R : Part or element manufactured by rolling (laminated)

S : Part or element manufactured with shrunk-on sheets (electrical devices)

MC : Materials testing including verification of chemical composition and measurement of mechanical characteristics.

HT : Verification of heat treatment (report). If no symbol appears, there may be heat treatment with no issuance of a report.

VI : Volume inspection (radiography, ultrasonic testing)

SI : Surface inspection (dye penetrant test, magnetic particle inspection)

WS : Welding specifications

VA : Visual assessment, surface state inspection (covers both the welding phase and the manufacturing phase complemented by a surface inspection in case of any doubt)

HTI : Hydraulic test inspection

Notes :

1) All items to be manufactured as per approved drawings.
2) Dimensional check is to be carried out for all items/equipments.
3) When a volume check (VI) or surface check (SI) is required by the chart, but the nature of that check is not established, the Contractor shall propose the most suitable method.

APPENDIX -II

FORGED PARTS

INVESTIGATION OF FAULTS

1.00.00 INVESTIGATION OF SURFACE DEFECTS

During various stages of manufacturing, surfaces are inspected closely to verify quality and dimensions of steel.

Steel parts shall be sound and free from surface flaking, scale, crack, chipping mark, bed, notch or other defects detrimental to their use.

Controls by magnetic particle inspection or dye penetration tests shall be carried out according to all situations foreseen in appendix 1.

For dye penetration test, following criteria shall be applied :

- indications upper to 2 mm are taken into account,
- following indications shall be researched, removed and eventually repaired:
  - Linear indications,
  - Non-linear indications upper than 3 mm,
  - aligned indications out of 3 (three) or more, with a distance between each of less than 3 mm(edge to edge),
  - grouped indications out of 5 (five) on a surface of 100 cm2 (100 sq cm) chosen unfavourably according to the number of indication without exceeding an upper limit of dimension of 20 cm.

For magnetic particle inspection, following criteria shall be applied :

- indications upper to 2 mm are taken into account,
- following indications shall be researched, eliminated and eventually repaired:
  - linear indications,
  - non-linear indications upper than 3 mm,
  - aligned indications out of 3 (three) or more, with a distance between each of less than 3 mm (edge to edge), or stretching on more than 15 mm, if their distance edge to edge is between 3 and 6 mm.

Two distinct indications are deemed one if distance between each is lower than two times the length of the smallest.

The length of the agglomerated indication shall be equal to the lump sum of the length of the two indications and the gap between each.

For austenitic stainless steel, only dye penetration test shall be performed.

2.00.00 INVESTIGATION OF INTERNAL DEFAULTS

2.01.00 Inspections to be performed

Parts are examined by ultrasonic method before forming, according to conditions forecast in appendix 1. Inspection is performed according to arrangements of EN-10228 standard.

Scanning is carried out by a square pattern and dimensioning of indications is performed by the equivalent diameter method (longitudinal waves).

For hollow cylindrical parts belonging to 3a and 3b divisions, an inspection with transverse waves shall be carried out according to EN-10228 standard, using reference notch method.

The Contractor may avoid final check by ultrasonic method on parts manufactured with semi finished products which have undergone ultrasonic inspection during forming.

2.02.00 Acceptance criteria

2.02.01 Longitudinal waves

The Contractor shall take into account criteria of quality class 2, except for trunnions, hoops, pinions, lifting hooks and transmission shafts where criteria of quality class 3 shall be applied.

2.02.02 Transverse waves

The Contractor shall apply criteria of EN-10228 standard.

2.02.03 Removal of damaged area

The Contractor shall remove only surface defaults, except for the compliance of dimensional tolerance limits of the part. After removal of defaults, the Contractor shall undergo an inspection by dye penetrant test or by magnetic particle.

Forged parts shall not be repaired by welding.

AC SYSTEM

1.00.00 CHILLING UNIT

1.01.00 Refrigerant Compressor (Reciprocating/ Screw/ Centrifugal)

1.01.01 Hydraulic/Pneumatic test of castings for cylinder block/crank case/casings shall be carried out. No leakage shall be permitted.

1.01.02 DPT of connecting rod, piston, crankshaft, screw, impeller, shaft, vanes, crank case/cylinder/casing etc. after machining shall be carried out.

1.01.03 All rotating parts of reciprocating, screw and centrifugal compressor shall be dynamically balanced to ISO 1940 Gr. 6.3

1.01.04 Leak tightness & vacuum check for chilling units / compressor in assembled condition shall be carried out. No leakage shall be permitted.

1.01.05 Performance test of assembled compressor shall be done to check for following:

(i) Capacity test for oil pump for reciprocating compressor.

(ii) No load air run (free run) test of all types of compressor to check FAD (Free air delivery), Noise, Vibration & Temp. rise of bearing & body.

(iii) Pump up & leak back rate for reciprocating compressor.

(iv) Functional run test and Capacity control check (for part load performance) shall be carried out.

2.00.00 CONDENSER & EVAPORATOR

2.01.00 DPT shall be carried out on welds.

2.02.00 10% RT of butt weld joint on shell shall be carried out.

2.03.00 Dimensional check including tube hole dia, ligament, pitch etc. shall be carried out.

2.04.00 Mock-up test of tubes to tube sheet expansion shall be carried out. In case such test is already carried out for similar tube/tube sheet thickness and materials, records for the same shall be furnished for THDC review.

2.05.00 Hydraulic/Pneumatic test of Shell Side and Tube Side of condenser and evaporator as applicable shall be carried out. 'No leakage' shall be permitted.

4.00.00 AIR HANDLING UNIT

4.01.00 20% DPT of welding on fan casing, impeller, hub, blades, hub as applicable shall be carried out.

4.02.00 UT on fan shafts (dia equal to or above 50mm) shall be carried out. DP of fan shaft after machining shall be carried out

4.03.00 Blower fan shall be dynamically balanced to ISO 1940 Gr. 6.3

4.04.00 One fan of each type and size shall be performance tested as per AMCA / BIS for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise and Vibration.

4.05.00 One per type of assembled AHU (AHU casing and fan assembly) shall be subjected to free run test. Noise, Vibration and Temp. Rise of bearing shall be measured during run test.

4.06.00 All cooling coil shall be pneumatically tested and no leakage shall be permitted.

5.00.00 CENTRIFUGAL PUMP

5.01.00 UT on pump shaft (dia equal to or above 50 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.

5.02.00 All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3

5.03.00 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.

5.04.00 Standard Running Test

5.04.01 All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only.

5.04.02 Noise and vibration shall be measured at shop for reference purpose only.

5.04.03 Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.

5.04.04 NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

6.00.00 COOLING TOWER

6.01.00 UT of fan shaft and drive shaft (dia equal to or above 50mm) shall be carried out.

6.02.00 DPT of fan hub and shafts shall be carried out after machining.

6.03.00 Colour of fills shall be as per approved data sheet.

6.04.00 Fan assembly shall be statically balanced.

6.05.00 Cooling Towers being supplied to site in assembled condition shall be subjected to run test at shop to measure FAD, Noise & Vibration. For Cooling Towers being supplied in knocked-down condition, these tests shall be done at site

7.00.00 FANS:

7.01.00 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

7.02.00 DPT of fan shafts shall be carried out after machining.

7.03.00 UT of fan shafts (dia equal to or above 50mm) shall be carried out.

7.04.00 Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3

7.05.00 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.

7.06.00 One fan of each type and size will be performance tested as per corresponding BIS code for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

8.00.00 LOW PRESSURE AIR DISTRIBUTION SYSTEM

8.01.00 Functional tests for fire damper along with solenoid shall be done.

8.02.00 Prototype tests report of fire damper (duly approved/accepted by ENGG) for each type and size as per UL-555 for fire rating shall be furnished.

8.03.00 Site Test- After completion, all ducting system shall be checked/tested for air leakages/tightness (smoke test) at site.

9.00.00 INSULATION :

9.01.00 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.

9.02.00 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density and thickness of material as applicable as per IS: 3346 or equivalent standard.

10.00.00 AIR FILTERS:

10.01.00 Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.

11.00.00 PIPES & FITTINGS:

11.01.00 All pipes and fittings shall be tested as per applicable codes / standard.

11.02.00 Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement

12.00.00 **VALVES & SPECIALTIES**

12.01.00 Visual and dimensional check of valves as per relevant codes and approved drawing.

12.02.00 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

12.03.00 Refrigerant line valves shall be pneumatically tested for body and seat leakage test.

12.04.00 Valves shall be offered for hydro test and pneumatic test in unpainted condition.

12.05.00 Functional check of the valves for smooth opening and closing shall be done.

12.06.00 Performance test to check pressure drop Vs flow shall be carried out for one valve of each type, size and rating for 'Balancing Valve'/Globe Valves with orifice.

12.07.00 Packaged Air Conditioners (PAC)

12.07.01 Compressor of packaged air conditioner shall be tested as per relevant codes

12.07.02 PAC shall be subjected to production routine test in accordance with IS: 8148 for the following.

a) General Running Test

b) Pressure/Leakage test

c) Insulation Resistance test

d) High Voltage test

e) Performance test on one PAC at ambient conditions

VENTILATION SYSTEM

1.00.00 FANS:

1.01.00 20% DPT of welding on fan hub, blades, casing and impeller as applicable shall be carried out.

1.02.00 DPT of fan shafts shall be carried out after machining.

1.03.00 UT of fan shafts (dia equal to or above 50mm) shall be carried out.

1.04.00 Rotating components of all fans shall be dynamically balanced to ISO-1940 Gr. 6.3

1.05.00 All Centrifugal Fans shall be subjected to run test for 4 hrs. or till temperature stabilization is reached. Vibration, Noise level, Temp. rise and current drawn shall be measured during the run test.

1.06.00 One fan of each type and size will be performance tested as per corresponding BIS code for Air flow, Static Pressure, Speed, Efficiency, Power Consumption, Noise, Vibration and Temp. Rise.

2.00.00 CENTRIFUGAL PUMP

2.01.00 UT on pump shaft (dia. equal to or above 50 mm) and MPI/DPT on pump shaft and impeller after machining shall be carried out.

2.02.00 All rotating components of the pumps shall be dynamically balanced to ISO-1940 Gr. 6.3

2.03.00 A standard hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut off pressure on the head characteristics curve or twice the rated pressure whichever is higher, for a minimum duration of 30 minutes.

2.04.00 Standard Running Test

2.04.01 All pumps shall be tested in the manufacturer's works preferably with contract motor for capacity, efficiency, head and brake horsepower. Pump shall be given running test over the entire operating range covering from the shut-off head to the maximum flow. The duration of test shall be minimum one (1) hr. A minimum of five readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standard (HIS) and/or as per applicable Indian Standard or equivalent. Acceptance norms shall be as per approved datasheet & HIS standard only.

2.04.02 Noise and vibration shall be measured at shop for reference purpose only.

2.04.03 Pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and/or excessive vibration are observed during the shop test.

2.04.04 NPSH test shall be conducted with water as the medium, if required as per approved data sheets.

3.00.00 LOW PRESSURE AIR DISTRIBUTION SYSTEM

3.01.00 Functional test for fire damper along with solenoid shall be done.

3.02.00 Prototype tests report of fire damper (duly approved/accepted by Engineering) for each type and size as per UL-555 for fire rating shall be furnished.

3.03.00 Site Test- After completion, all ducting system shall be checked/ tested for air leakages/tightness (smoke test) at site.

4.00.00 **INSULATION:**

4.01.00 Insulation material shall be tested for all mandatory tests only as per relevant code/standard.

4.02.00 Thermal conductivity tests (for thermal insulation only) shall be done once in six months for insulation material manufactured during six months period for the same density and thickness of material as applicable as per IS: 3346 or equivalent standard.

5.00.00 **AIR FILTERS:**

5.01.00 Pre/Fine filters shall be tested for initial and final pressure drop Vs flow and average synthetic dust weight arrestance as per the requirement of BS 6540/ASHARE-52-76/EN779. HEPA (Absolute) filters shall be tested as per applicable code.

6.00.00 **PIPES & FITTINGS:**

6.01.00 All pipes and fittings shall be tested as per applicable codes / standard.

6.02.00 Site test- Pipes shall be tested at site hydraulically/pneumatically as per application requirement.

7.00.00 VALVES & SPECIALTIES

7.01.00 Visual and dimensional check of valves as per relevant codes and approved drawing.

7.02.00 All the water line valves shall be hydraulically tested for body, seat and back seat (wherever provided) as per the relevant standard to which these valves are supplied irrespective of the working pressure for which these valves are selected. Check valves shall also be tested for leak tightness test at 25% of the specified seat test pressure.

7.03.00 Valves shall be offered for hydro test and pneumatic test in unpainted condition.

7.04.00 Functional check of the valves for smooth opening and closing shall be done.

7.05.00 **AIR WASHER AND UAF (UNITARY AIR FILTERATION) SYSTEM**

7.06.00 **Random 10% DPT on welds**

7.06.01 Hydraulic test of pressure parts at 1.5 times the design. Pressure and water fill test of tanks shall be carried out.

7.06.02 Trial assembly of Air washer/UAF for one of each size shall be done in shop.

CLAUSE NO.	QUALITY ASSURANCE AND TESTING	

CENTRIFUGAL PUMPS: Piping, Valves & Fitting and Painting

1.00.00	**CENTRIFUGAL PUMPS**
	(HORIZONTAL / VERTICAL / VERTICAL TURBINE PUMPS / SUBMERSIBLE PUMPS)
	The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.
1.01.00	**Hydrostatic Tests**
	A Standard Hydrostatic test shall be conducted on the pump casing with water at 1.5 times the shut-off pressure on the head characteristic curve or twice the rated pressure, whichever is higher. While arriving to the above pressure, the maximum suction head specified in Data Sheet shall be taken into account. The hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.
1.02.00	**Performance Tests**
	a. All the pumps shall be performance tested at the Manufacturer's Works over for entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at rated – flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards, USA or as per applicable equivalent Codes/Standards. b. The performance tests shall be tested at rated speed only. c. The pumps for which LD on power consumption is applicable, – shall be tested with the actual drive motor being furnished. For other pumps the test may be conducted with calibrated shop motor. d. Pumps shall be subjected to strip down examination visually to check for mechanical damages after performance testing at shop.
1.03.00	**For Vertical Turbine Pumps**
1.03.01	After the manufacture, the pumps shall be subjected for a prototype performance test at the manufacturer's works to determine the power consumption and the head capacity characteristic in the presence of Owner's representative as per requirements of BS:5316, HIS, USA or equivalent. Performance test at design duty point shall be done keeping minimum submergence of the pump identical to that specified for the site conditions. Bidder shall submit the test procedure for Owner's approval after award in case such test facilities are not available at manufacturer's works the test may be carried out at any other test facility with the approval of the Owner. All costs associated with testing at Contractor's works or at any other test facility shall be included in contract price.
1.03.02	Contractor shall submit along with his offer details to the proposed test facilities available for testing the pumps. The details must include the capacity, head, maximum motor rating, voltage level sanctioned load and permissible starting current.
1.03.03	No negative tolerance shall be permitted on head (H), capacity (Q) and the pump efficiency (n) during shop tests. Accuracy of instruments used shall be +1.5% or better for measurement of flow and +0.5% or better for measurement of pressure and power.

1.04.00	Noise and Vibration Levels
	Noise and vibration shall be measured during the performance testing at shop as well as during the site test. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out all round the pump and motor set at a distance of one meter from the nearest surface of the machine at a height of 1.5m from the floor level. A minimum of six (6) points should be covered for measurement. The tests shall be carried out with the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should be collected during the test. Vibration level check will be done as per Hydraulic Institute Standards. Vibration would be checked at thrust bearing location in horizontal, radial and vertical directions. Acceptable limits would be as per Hydraulic Institute Standards.
1.05.00	**Mechanical Balancing**
1.05.01	Rotating components of the pumps shall be subjected to dynamic balancing tests as per ISO-1940, Gr.6.3 or better.
1.06.00	**Visual Inspection**
1.06.01	Pumps shall be offered for visual inspection to the Owner before shipment. The components of the pumps shall not be painted before inspection.
1.07.00	**Material Test Certificate**
	Materials of the various pump components shall be tested in accordance with the relevant standards. Test Certificates for these shall be furnished for the Owner's approval. Where stage inspection is specified, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by Owner's inspector who shall stamp the material. In case mill test certificates for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, as per the requirement of specified material standard.
1.08.00	**Non-Destructive Testing**
	Non-destructive testing of the pump components shall be conducted in accordance with relevant standards and as specified in Table.

CLAUSE NO.	QUALITY ASSURANCE AND TESTING	

2.00.00	**PIPING, VALVES AND FITTINGS**
2.01.00	**Piping & Fittings**
	All the mechanical and chemical tests including optional tests if any as per the relevant standards shall be carried out and the test certificates for the same shall be submitted for owners approval. The minimum hydraulic testing criteria for all the pipes before and after the rubber lining (if provided) shall be at two times, the operating pressure or 1.5 times the maximum attainable pressure for a period of 30 minutes, whichever is greater. However, if the Standard of supplied piping specifies more stringer requirements than the above criteria, then the hydraulic tests shall be conducted as per the piping standard. For rolled and welded pipes quality requirements refer sub section III-E01 "Cooling towers –Mechanical" "All pipes and fittings shall be visually and dimensionally examined as per applicable standards."
	All rubber lining is to be subjected to the following tests as per IS:4682 part I (a) Adhesion test (b) Tests to check resistance to bleeding (c) Measurement of thickness of lining (d) Shore hardness test (e) Spark test at High voltage 5 KV/mm of thickness Welding procedure and welder performance qualifications shall be carried out.
2.02.00	**Valves/Gates/Strainers**
	Rubber lining on valves Gates/Strainers shall be checked in accordance with IS:4682 Part I for the following tests :
	(a) Adhesion test (b) Tests to check resistance to bleeding (c) Measurement of lining thickness (d) Shore hardness test (e) Spark test at high voltage at 5 KV/mm of thickness.
	Gates shall be tested against leakage and strength as required in the standard. Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.
3.00.00	**PAINTING** All painted surfaces shall be visually checked for uniformity. The dry film thickness of coating of paint shall be measured.

COOLING WATER SYSTEM

Items / Components \ Tests/ Check		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Standard/ Approved Data Sheets	Remarks
A.	**PUMPS ***									Y[1]	Y		Y[2]			
1	Shaft	Y[a]		Y[b]	Y[c]						Y					
2	Impeller	Y[a]		Y[b]		Y[3]	Y									
3	Suction Bell / Bowl Castings/ Inserts	Y[a]		Y[b]				Y			Y			Y[6]		
4	Discharge Head / Column Pipes / Distance Piece	Y[a]	Y	Y[b]		Y[4]		Y		Y				Y[5]		
B.	**BUTTERFLY VALVES**							Y[7]		Y	Y	Y		Y[8]	**Y**	
1	Body & Disc	Y[a]		Y[b]										Y[9]		
2	Shaft	Y[a]		Y[b]	Y[c]											
3	EH Actuators	Y[a]		Y				Y	Y	Y		Y				
C.	**RE JOINTS**	Y[a]						Y[10]		Y	Y			Y[11]		
D.	**STOP LOG GATES**	Y[a]		Y[b]						Y	Y			Y[12]		
E.	**R & W PIPES**	Y[a]		**REFER NOTE 13**												
F.	**CRANES & HOISTS**	Y[a]		Y[b]	Y[c]	Y[14]				Y	Y	Y		Y[15]	Y[16]	

Remarks: See following NOTES.

COOLING WATER SYSTEM

Items / Components \ Tests/Check		Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Ultrasonic test	RT	Balancing	Hydraulic / Water Fill test	Pneumatic Test	Assembly/ fit up	Dimensions	Functional/operational Test	Performance Test	Other Test	All Test as per relevant Standard/ Approved Data Sheets	Remarks
G.	**VENTILATION FANS**										Y		Y			
1	Hub/Blades/Casing /Impeller	Y		Y			Y									
2	Shaft	Y[a]		Y	Y[c]											
3	Pre/Fine Filters													Y[17]		

* PUMPS mean Pumps in primary and secondary circuits

Remarks: See following NOTES.

a	One per Heat/ Heat Treatment Batch/ Lot.
b	On machined surfaces only for Castings / Forgings and on Welds of Fabricated Components. 100% DP test on butt weld joints of Girder, End Carriage, Crab (in tension, compression) and in butt weld joint of rope drum
c	For Shaft diameter. ≥ 40 mm and for forged part / plate thickness ≥ 40 mm (in case of EOT crane components)
1	Trial assembly of all Vertical Turbine Pump components with Column Pipes, Discharge Head, and Motor Stool shall be carried at shop.
2	Performance testing of Pumps shall be carried out at shop, as per HIS standard to determine Head & Flow Characteristics.
3	Radiographic Examination shall be conducted as per ASTM E186/E446 with Severity Level 2 for Gas porosity, Level 3 for Sand, Slag and Shrinkage. Cracks, Inserts and Mottling are not acceptable. Radiographic Examination should cover Vanes, Vane Junctions, Full Radial depth of Hub & other accessible areas of the rest of the Impeller.
4	Spot Radiography for Butt weld of Fabricated Components for thickness of 10mm & above shall be carried out.
5	Segmental Flanges exceeding 37.5 mm thickness shall be stress relieved after welding. All butt weld joints in segmental flange shall be examined by Radiographic Test. (RT may be replaced by Ultrasonic Test due to constraint if any.) Maximum number of segments shall be 4 only.
6	No repair welding is permitted on Cast Iron / Alloy Cast Iron Castings.
7	Hydraulic Test of Body, Seat and Disc strength shall be carried out in accordance with latest edition of AWWA C-504. Actuator operated Valves shall be checked for Seat Leakage by closing the Valve with Job Actuator. Seat Leakage test shall be carried out in both directions.
8	Proof of Design Test shall be carried out in presence of Owner's representative, if not carried out earlier under Third Party Inspection, in line with AWWA C-504 requirements. In case of Valves > 72" size, number of Cycles shall be 1000, for each Size & Class of Valve offered. Valve subjected to POD Test shall not be supplied to Owner.
9	For Butterfly Valves of Fabricated construction (Sizes 600mm and above) Butt Welds of thickness 20mm & above shall be subjected to 100% Radiography and Component shall undergo stress relieving.

<table>
<tr><td>10</td><td colspan="2">During Hydraulic & Vacuum test at 25mm Hg absolute in 3 different positions, the change in Circumference of the Arch should not be more than 1.5%. Permanent Set, after 24 hours of the test, should not exceed 0.5% of Arch.</td></tr>
<tr><td>11</td><td colspan="2">Tests on Rubber for Tensile, Elongation, Hardness, Hydraulic Stability as per ASTM D-471, Ozone Resistance test as per ASTM D-1149, Aging test, Fabric Strength of Synthetic Fiber, Adhesion strength of Rubber to Fabric and Rubber to Metal shall be carried out.</td></tr>
<tr><td>12</td><td colspan="2">Smooth operation and Leakage test shall be carried out at site.</td></tr>
<tr><td>13</td><td colspan="2">Followings are the testing requirements for fabrication of pipes at site / manufacturing works

<table><tr><th>Tests</th><th>Quantum of Check</th></tr><tr><td>WPS, PQR, Welder Qualification Test</td><td>100%</td></tr><tr><td>DPT on root run</td><td>100% for pipes up to 1200 mm diameter</td></tr><tr><td>DPT after back gauging</td><td>100% for pipes above 1200 mm diameter</td></tr><tr><td>RT</td><td>5%</td></tr><tr><td>DPT on finished butt weld joints</td><td>10%</td></tr><tr><td>Hydraulic Test</td><td>1.5 times the design pressure or 2 times the working pressure which ever is higher.</td></tr></table></td></tr>
<tr><td></td><td colspan="2">Note:- Butt weld joints which can not be hydraulic (pressure) tested; shall be examined 100% by Radiographic Test (RT)</td></tr>
<tr><td>14</td><td colspan="2">100% RT shall be carried out on Butt – weld joints in tension and in Butt Weld Joints of rope drum. 10% RT shall be carried out on Butt – weld joints in compression.</td></tr>
<tr><td>15</td><td colspan="2">Reduction gears shall be tested for reduction ratio, backlash and contact pattern. Gear box shall be subjected to no – load test to check for oil leakage, temperature rise, noise and vibration.</td></tr>
<tr><td>16</td><td colspan="2">Full Load and Overload test shall be carried out at shop as per the governing standard. All motions including performance of Electro-Mechanical Brakes if any shall also be checked.</td></tr>
<tr><td>17</td><td colspan="2">Type / Routine tests as per requirements of BS-6540/ ASHRAE-52-76 for Dust arrestance shall be carried out.</td></tr>
</table>

	EQUIPMENT COOLING WATER SYSTEM												
	TEST / CHECKS / ITEM / COMPONENTS	Material Test	WPS/PQR/Welder Qualification	DPT/MPI	Assembly Fit Up	Visual & Dimensional Check	UT	RT	Hydraulic / Water Fill	Balancing	Type Test	Performance Test	Other Test
A	**PLATE TYPE HEAT EXCHANGER**		Y	Y[3]	Y	Y			Y				
A.1	Heat Transfer Plates	Y[1]		Y[2]		Y	Y[5a]						Y[7]
A.2	Gaskets	Y				Y							
A.3	Cover Plates (Front & Rear)	Y[1]				Y	Y[5a]						
A.4	Tie Rods	Y[1]		Y[4]			Y[6]						

NOTES

1 One per heat / HT batch

2 DP Test shall be conducted for 10% of the lot of HT plates. However, in case of any defect, entire lot shall be tested and only defect free plates shall be accepted.

3 100% DP Test shall be conducted on butt welds and 10% DPT on fillet weld after final run.

4 100% DPT shall be carried out on machined surfaces.

5 UT shall be done on plates with thickness 25 mm or above.

6 UT shall be done on shaft / tie rod with diameter 50 mm or above.

7 Each Plate after pressing shall be subject to either of the following tests, as per Manufacturer Practice

a) Light Box Test b) Vacuum Test c) Air Chamber Test

SECTION: I

SUB-SECTION: C3

TECHNCIAL SPECIFICATION

(ELECTRICAL PORTION)

4 X 111 MW VISHNUGAD PIPALKOTI HEP

TECHNICAL SPECIFICATION FOR
HVAC
(ELECTRICAL PORTION)

REVISION 00

BHARAT HEAVY ELECTRICALS LIMITED

POWER SECTOR

PROJECT ENGINEERING MANAGEMENT

NOIDA, INDIA

CONTENTS

S NO.	DESCRIPTION	NO. OF SHEETS
	SCOPE	2
	LT SWICHGEAR	120
	LT POWER, CONTROL & INSTRUMENTATION CABLE	137
	LT MOTORS	16
	CABLING, EARTHING & LIGHTNING PROTECTION	15

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER:

a) Services and equipment as per "Electrical Scope between BHEL and Vendor".

b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.

c) Supply of mandatory spares as specified in the specifications.

d) Erection and Commissioning spares.

e) Erection & Maintenance tools & tackles.

f) Electrical load requirement for HVAC.

g) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.

h) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL.

i) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.

j) Motor shall meet minimum requirement of motor specification.

k) LT switchgear panels shall meet minimum requirement of LT switchgear specification.

l) LT power & control cables shall meet minimum requirement of LT power & control cables specification.

m) Cabling, earthing & lightning protection shall meet minimum requirement of cabling, earthing & lightning protection specification.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer "Electrical Scope between BHEL and Vendor".

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/quality assurance requirements stipulated. In line with these two signed and stamped copies of the following shall be furnished by the bidder as technical offer:

a) A copy of this sheet **"Electrical equipment Specification for HVAC"** and sheet **"Electrical Scope between BHEL and Vendor"** with bidder's signature and company stamp.

b) List of Erection and Commissioning spares.

c) List of Erection & Maintenance tools & tackles.

d) Electrical load requirement

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

4.0 List of enclosures:

a) Electrical scope between BHEL & vendor.
b) Technical specification, datasheets & quality plans for 415V Electric motors.
c) Technical specification, datasheets & quality plans for 415V LT Switchgear.
d) Technical Specification, datasheets & quality plans for LT power & control cables.
e) Technical Specification, datasheets & quality plans for cabling, earthing & lightning protection.
f) Electrical Load data format.

5. The stipulations of specification **(in decreasing order)** Section-C (customer specification) followed by Datasheet-A shall prevail in case of any conflict between the stipulations of specification Section-C (customer Specification) and Datasheet-A.

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER-THDCIL SCOPE)

PROJECT:

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	Vendor	1. 415 V AC/240 V AC supply shall be provided by Vendor *
2	Local Push Button Station (for motors)	Vendor	Vendor	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in vendor's scope b) one end equipment in vendor's scope	 Vendor Vendor	 Vendor Vendor	1. Finalisation of cable sizes shall be done by Vendor meeting specification requirements. Vendor shall provide lugs & glands accordingly. 2. Laying of cables by Vendor. 3. Termination at equipment terminals by Vendor.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	Vendor	
5	Cable trays, accessories & cable trays supporting system	Vendor	Vendor	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power cables 3. Solder less crimping type heavy duty copper lugs for control cables.
7	Conduit and conduit accessories for cabling between equipments supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537. Makes of conduits shall be subject to customer approval at contract stage.
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	Vendor	Vendor	
10	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer approval at contract stage.
11	Mandatory spares	Vendor	-	Vendor to quote as per specification.
12	Recommended O & M spares, E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
13	Any other equipment/material/service required for completeness of system but not specified above (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
15	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing & cable routing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies.

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE: HVAC (CIVIL IN CUSTOMER-THDCIL SCOPE)

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
16	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details. Electrical equipment layout drawing shall be to BHEL approval.
17	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.

LT SWITCHGEAR

SECTION – 20

TECHNICAL SPECIFICATION OF LTAC SYSTEM

20.1 SCOPE

20.1.1 This section of specification covers the design, manufacture, assembly, testing at manufacturer's works before despatch, supply & services towards transportation, insurance, storage & preservation at site, erection, testing and commissioning & handing over, remedial action, if any upto defect liability period of 415V metal enclosed unit auxiliary & station auxiliary switchgears/boards suitable for indoor installation for providing AC supply to various equipment located at various floors in M/C hall cavern, transformer hall cavern, B.F. valve chamber, Surge shaft area, pothead yard, dam site, desilting chambers & TRT outfall areas etc. All inter panel cables and all other accessories required for its satisfactory operation as detailed here under and given in the schedule of requirements shall be covered in the Scope of supply.

20.1.2 The scope of supply for these AC distribution switchgears / boards also covers suitable over current, earth fault, under voltage / no-voltage protection relays for incoming, outgoing and motor feeder and tie incorporating interlocking scheme and air circuit breakers as detailed under clause 20.7.21 & 20.7.22. The incoming/outgoing feeders shall be provided with air circuit breakers/moulded case circuit breakers as shown in the relevant drawing enclosed as Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement" in the bidding documents. The moulded case circuit breakers and low current outgoing feeder MCBs shall be suitably designed for thermal overload and magnetic short circuit protection. 0.415kV segregated/non-segregated three phase and neutral (TPN) bus-duct/bus bars of adequate size, nut, bolts etc. required for inter connection between 0.415kV metal clad switchgears, 0.415kV switchgears & SATs and for inter panel connections are also included in the scope of supply. Metering equipment consisting of volt meters, ammeters and energy meters shall be provided for all incoming feeder breakers alongwith current and potential transformers.

20.1.3 The scope of the supply also includes necessary special tools and plants required for erection and maintenance of these switchgears/boards. The bidder shall also list out in its bid, the details of tools and plants covered under the scope of supply. Any other equipment not explicitly mentioned herein/Schedule of requirement but is necessary for completeness & successful commissioning of equipment specified shall deemed to be included in the scope.

20.2 0.415 kV LT SWITCHGEARS

20.2.1 The LT system of power house is planned and designed for supplying AC power to the various auxiliaries of the generating units, transformers, GIS, pothead yard equipments and other various station auxiliaries such as illumination, ventilation air conditioning, compressed air system, cooling water system, drainage/dewatering system, drinking water system etc. for the complete power house complex and also meet the power requirement of gates and their accessories, illumination, ventilation etc. of dam site &, desilting chambers area.

20.2.2 14 (Fourteen) Nos. 0.415kV, metal enclosed, air insulated, LT switchgears (SGs) comprising of 4 (four) SGs for power supply to unit auxiliaries and 10 (ten) (SGs) to feed the common station auxiliaries have been proposed (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". These switchgears are briefed hereunder:

i) **UAB (1-4)** – These units auxiliary SGs are located on generator floor (U/S) at EL 1032.0m in generator floor. Each UAB is fed power from 400kVA; 13.8/0.433KV UAT of individual unit. UAB-1 & 2 will also be connected independently with SAB-4 to receive power for unit auxiliaries at the time of the starting of the unit and UAB-3 & 4 will be connected to SAB-2.

ii) There shall be two (2) nos. 415 V Switchgears in Power House. One no. switchgear shall be located at one end of Power House comprising of SAB-1, SAB-2 & SAB-3 and 2nd switchgear shall be located at other end of Power House (SAB-4).

SAB (1-3) - This station auxiliary switchgear (named as No.-1) shall comprise of four sub sections, SAB-2 (two sections), SAB-1 and SAB-3. The SAB-2 shall be provided with bus coupler and shall be divided into two sections. SAB-1 and SAB-3 shall be connected to SAB-2 through two air circuit breakers. The non-essential loads shall be connected to SAB-1 and SAB-3 and the essential loads shall be connected to SAB-2 only. These station auxiliary SGs are located on M/C hall cavern at EL 1038 M in Power House. Switchgear SAB-2 will be fed LT power from 11 kV metal enclosed switchgear (SSB-1) located nearby on the same floor through 1600 kVA, 11/0.433 kV station auxiliary transformers (SAT-1 & 2).

SAB-4- The switchgear SAB-4 shall be located at other end of power house and shall be named as 415 V Station auxiliary Switchgear No. 2. The power supply to UAB-1 and UAB-2 shall be

given through this SAB-4 whereas power supply to UAB-3 & UAB-4 shall be fed through SAB-2 (through two different sections 1 & 2). Switchgear SAB-4 will be fed LT power from 11 kV metal enclosed switchgear (SSB-1) located nearby on the same floor through 1250 kVA, 11/0.433 kV station auxiliary transformers (SAT-3 & 4).

iii) **SAB-5** – This station auxiliary SG shall be located in transformer hall cavern at El. 1038m and will fulfill the power requirement of transformer hall/GIS hall. The switchgear is getting the supply from SSB-1 located in Power House. Switchgear is sectionalized in two parts, one is connected to section-1 of SSB-1 and other is connected to section-3 of SSB-1. Switchgear SAB-5 will be fed LT power from 11 kV metal enclosed switchgear (SSB-1) located nearby on the same floor through 630 kVA, 11/0.433 kV station auxiliary transformers (SAT-5 & 6).

iv) **SAB-6**-This station auxiliary SG is located in TRT outfall area at EL 1025 M. The LT supply to this SG will be fed from Potheadyard through two 250 kVA, 11/0.433kV SAT 7 & 8. This switchgear shall be provided with bus coupler. The logic of operation is such that when both the incomers are healthy, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler shall close and power supply shall be fed from another incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

v) **SAB-7**- This station auxiliary SG is located in pothead yard. This SG will be fed LT power from SSB-2 (11 kV metal enclosed switchgear) located in the same vicinity through 630kVA, 11/0.433kV SAT-9 & 10. This switchgear shall be provided with bus coupler. The logic of operation is such that when both the incomers are healthy, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

vi) **SAB-8**- This station auxiliary switchgear is located in the dam area at EL. 1270 M. The LT supply to this switchgear will be fed directly from nearby S/S through 250 kVA, 11/0.433 kV, SAT–11

& 12. This switchgear shall be provided with bus coupler. The logic of operation is such that when both the incomers are healthy, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be feed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders. Under emergency condition, when both incoming feeders supply are not available only then 200KVA, 415V DG (DG-III or DG-IV) set will be switched ON and power to all the essential services will be restored. The operation of DG set shall be manual and there shall be no automatic switching ON of DGs in the event of failure of all the supplies. In the event of failure of both incoming supply only one DG set will be switched on and the other shall be in standby condition. Both the DGs shall never be switched on simultaneously.

vii) **SAB-9**- This station auxiliary switchgear is located at the entrance of adit to the de-silting chambers area at EL 1270 M. The LT supply to this switchgear will be fed directly from nearby S/S through 250 kVA, 11/0.433 kV, SAT – 13&14. This switchgear shall be provided with bus coupler. The logic of operation is such that when both the incomers are healthy, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

viii) **SAB-10**- This station auxiliary SG is located in the Butterfly Valve Chamber/Surge shaft area at EL. 1175M. The LT supply to this switchgear will be fed directly from nearby S/S through 250 kVA, 11/0.433 kV, SAT – 15&16. This switchgear shall be provided with bus coupler. The logic of operation is such that when both the incomers are healthy, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.3 SCHEME OF OPERATION FOR 0.415 kV LT SWITCHGEAR SYSTEMS

20.3.1 LTAC Power Supply Scheme for Power House Complex

20.3.1.1 Initially when all the generating units are at standstill, the power requirement of unit auxiliary switchgears / boards UAB (1-4) shall be met through 415V metal enclosed switchgear (SAB-2 & 4). The units shall be started one at a time. After the unit is synchronized the auxiliary power requirement of the generating unit shall be met by the respective 400kVA, 13.8/0.433kV, unit auxiliary transformer (UAT) and the incomer breaker from SAB-2 or 4 supplying power to UABs shall be switched-off automatically before closing of circuit breaker of UAT. The 1600 kVA, 11/0.433 kV station auxiliary transformers (SAT-1&2) and 1250 KVA, 11/.433KV station auxiliary transformers (SAT-3 & 4) located inside the Power House Cavern shall be fed power continuously from SSB-1 (11 kV metal enclosed switchgears) through 11 kV XLPE insulated cables to meet the requirements of LT power of the station auxiliaries. 630KVA, 11/.433KV station auxiliary transformers (SAT-5 & 6) located in the transformer hall cavern shall also be fed from SSB-1 through 11kV XLPE insulated cables to meet the requirement of LT power of Transformer/GIS auxiliaries. The auxiliaries will receive power at 0.415 kV from the station auxiliary switchgears / Boards SAB (1-4) located in M/C hall & SAB-5 in transformer hall caverns.

20.3.1.2 The auxiliaries at TRT outfall area will get LT power from SAB-6 through station auxiliary transformers (SAT 7 & 8) of 250 KVA, 11/.433KV. The auxiliaries at Pothead yard will get LT power from SAB-7 through station auxiliary transformers (SAT 9&10) of 630KVA, 11/0.433KV. The respective station auxiliary transformers shall be fed from SSB-2 (11 kV metal enclosed switchgears) through 11KV XLPE insulated cables to meet the requirement of LT power of auxiliaries.

20.3.1.3 The auxiliaries at Butterfly Valve chamber area will get LT power from (SAB-10) through station auxiliary transformers (SAT 15 & 16) of 250KVA, 11/0.433KV. These station auxiliary transformers shall be fed from nearby S/S to meet the requirement of LT power of B.F.V. chamber /surge shaft auxiliaries. .

20.3.1.4 It is proposed that in normal case the 11 kV Switchgear (SSB-2) shall be fed from two outside independent S/S from local sources. If one source fails, the entire auxiliary system shall be fed from 2nd source and bus coupler shall be closed in this case. When incoming supply is restored, then bus coupler will open and power shall be fed from two independent sources.

If both the supplies fails and units are generating, then power shall be fed from Station Service Transformers. Under emergency conditions when neither of above sources of power (i.e. two outside sources or supply from SSTs) are available only then the diesel generator set will be switched on and power to all the essential services will be restored through both the 11 kV switchgears. The operation of diesel generator shall be manual and there will be no automatic switching ON of diesel generators in the event of failure of all three sources. It should be possible to switch ON only one diesel generator and the other shall always be in standby condition. Both the diesel generators shall never be switched on simultaneously.

The interlocking scheme shall be suitably designed to fulfill the above functional requirement.

20.3.2 LTAC Power Supply Scheme for Dam Site & Desilting Chamber Area

20.3.2.1 As described under items (vi) & (vii) of clause 20.2.2 above, this scheme is completely isolated from the LTAC scheme of power house. The switchgear SAB-8 located at Dam site will receive power directly from 11KV S/S to be constructed at Dam site for supply of construction power through 2 Nos. 250 kVA, 11/0.433 kV station auxiliary transformers (SAT – 11 & 12). Similarly SAB-9 located in desilting chambers area will receive power directly from same S/S through 2 Nos. 250 kVA, 11/0.433 kV station auxiliary transformers (SAT – 13 & 14).

20.4. CODES AND STANDARD

All the equipment and materials shall be designed, manufactured, and tested, except where all modified and/or supplemented by the specification, in accordance with the latest applicable Indian Standard (IS) and the following IEC publications:

IEC 44-1	Instrument transformers – part 1: Current transformers
IEC 51	Directing acting indicating analog electrical measuring instruments and their accessories
IEC 158-1	Contactors
IEC 185/ IS2705	Current transformer
IEC 186/ IS 3156	Voltage transformer
IEC 255	Electrical relays
IEC 292	Motor starters

IEC 364-3	Electrical installations of buildings- Part 3: Assessment of general characteristics
IEC 408	Low voltage air break switches, air break disconnectors, air-break switch and fuse combination units
IEC 439	Low voltage switchgear and control gear assemblies
IEC 473	Dimensions for panel-mounted indicating and recording electrical measuring instruments
IEC 529	Degree of protection provided by enclosure
IEC 664	Insulation coordination within low voltage system
IEC 688	Electrical measuring transducers for converting ac electrical quantities to analog or digital signals
IEC 715	Dimensions of low voltage switchgear and control gear standardize mounting on rails for mechanical support of electrical devices in switchgear and control gear installations
IEC 865	Short circuit current – Calculation of effects
IEC 870-2	Telecontrol equipment and system – part 2: Operating conditions
IEC 898	Electrical accessories – Circuit breakers for over current protection for house hold and similar installations
IEC 947	Low voltage switchgear and control gear
IEC 1008	Residual current operated circuit breaker without integral over current protection for house hold and similar installation
IEC 1010	Safety requirements for electrical equipment for measurement, control and laboratory use
IEC 1200	Electrical installation guide (Selection and erection of electrical equipment) in switchgear and control gear
IS 375	Colour code of bus bar
IS 1293	Specification for three pin plugs and socket outlets
IS 1336/6875	Specification of push buttons, switches etc.
IS 2147	Specifications of metallic enclosure
IS 2148	Specification for flame proof enclosures of electrical apparatus
IS 2208 & IS 9224/9385	Specification of HRC cartridges and fuse links upto 650V
IS 2859 &	Specification of contactor for voltage not exceeding 1000V AC or 1200V IS 13947(IV) DC
IS 3231 & IS 8686	Specification of electrical relays for power system protection
IS 3659 &	Specification for heavy duty air circuit breakers for AC system

IS 8828/ 4064 / IS13947(II)	
IS 4237	Specification of low voltage switchgear and control gear
IS 5	Colour shades
IS 1554	Specification of PVC insulated heavy duty electrical cables
IS 1897	Chopper strips
IS 4064	Heavy duty air break switches & fuses of voltage not exceeding 1000V
IS 5578 & IS 11353	Marking and arrangement for switchgear bus bars main contacts and auxiliary wiring
IS 3072 IS 10118	Code of practice for installation & maintenance of and switchgear controlgear
IS 3202	Code of practice for climatic proofing of electrical equipment
IS 8623	Specification for factory built assemblies of low voltage switchgear for voltage upto and including 1000V and 1200V DC
IS 13947(I)	General requirement for switchgear and control gear for voltages not exceeding 1000V
IEC 298	AC metal clad switchgear
IEC 694	Common clauses for high voltage switchgear and control gear standards
IEC 60	High voltage test techniques
IEC 137	Bushings for alternating voltages above 1000V
IEC 233	Test on hollow insulators for use in electrical equipment
IEC 947-2	Low voltage switchgear and control gear
BS 159	Specification for high voltage bus bars and bus bar connections
IEC 73	Colours of indicator lights and push buttons
IEC 288	PVC insulated cables for switchgear and control gear wiring

Indian electricity rules 1956 and Indian electricity act 910 (Section IV) latest rev. for electrical works.

Equipment and materials confirming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

The electrical installation shall meet the requirements of Indian electricity rules as amended up to date and relevant IS code of practice.

In addition, other rules or regulations applicable to the work shall be followed. In case of any discrepancy, the more restrictive rule shall be binding.

The Tenderer shall furnish the schedule of recommended standards and codes in format of Annexure-4.

20.5 PROTECTION AGAINST EARTHQUAKE

Project is being located in an earthquake prone region of seismic zone IV (as defined in IS: 1893-fourth revision in 1984- Criteria for Earthquake resistant design of structure) of India which is prone to severe earthquakes. The equipments shall be designed for seismic co-efficient values of 0.38 g in horizontal direction and 0.19 g in vertical direction. To prevent equipments movement during earthquake, clamping device shall be provided for fixing the LT switchgears/boards to the foundation. Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangement shall be such that the LT switchgears/boards can be fixed to or unfastened from these bolts as desired. The fixing of the LT switchgear to the foundation shall be designed to withstand the seismic events. It will also be ensured that the clamping device as well as bolts shall not be overstressed. Details of the device used and its adequacy shall be furnished by the supplier and shall be subject to purchaser's approval.

20.6 TECHNICAL DATA & RATINGS

20.6.1 Metal enclosed LT Switchgears / boards shall be installed at the following sites, approximate altitudes of which are given against each. Necessary care shall be taken for the altitude correction factors while designing the LT distribution boards.

i)	UAB-1 to 4	Generator Floor	El 1032 M
ii)	SAB-1 to 3	M/C Hall Cavern (One end of power house)	El 1038 M
iii)	SAB-4	M/C Hall Cavern (Other end of power house)	El 1038 M
iv)	SAB-5	Tr. Hall Cavern	EL 1038 M
v)	SAB-6	TRT outfall area	El 1025 M
vi)	SAB-7	Potheadyard	El 1150/55 M

vii)	SAB-8	Dam area	El 1270 M
viii)	SAB-9	Desilting Chamber	El 1270 M
ix)	SAB-10	Butterfly valve chamber El 1175M	

20.6.2 Other technical particulars to be considered for the detailed design of L.T. switchgears/boards are given below :-

1. Switchgear Cubicles & Bus-Bars

i)	Type	Metal enclosed, dust proof, air insulated, indoor-type
ii)	Protection class	IP-54
iii)	Rated system voltage	415 V±10%
iv)	Highest system voltage	1000V
v)	Phase system	3-phase, 4 wire system (3 phase + 1 neutral, Neutral section = 50% of phase section)
vi)	System earthing	Solidly earthed
vii)	System frequency	50 Hz ± 3%
viii)	Short time withstand current	50kA for all the panels
ix)	Dynamic breaking & making current	130 kA (peak)
x)	Insulation level - One minute power frequency withstand voltage for	
	a) Power circuits	2.5 kV (rms)
	b) Control Circuits	2.5 kV (rms)
xi)	Normal current rating of bus-bars	As per schedule of requirements
xii)	Control Voltage DC/AC Equipment	
	a) Closing	220V d.c. (80 - 110%)
	b) Tripping	220V d.c. (70 - 110%)
	c) Spring charging motors	220V d.c. (90 - 110%)
	d)Control voltage AC equipment	(240V ± 10%) V A.C.
	e) Service voltage AC equipment	(240V ± 10%) V A.C.

*** Note:** If D.C. control voltage is required the same be arranged through Individual power pack units (if required) of sufficient capacity for DC voltage requirement in B.F.V. Chamber, Pothead yard, Dam site & Desilting Chambers area shall have to be supplied by the bidder.

2. Air Circuit Breakers (ACBs) : Draw out type

i)	Voltage	:	3 phase, 415V ± 10 %
ii)	Frequency	:	50 Hz ± 3%
iii)	Short Circuit performance category	:	P2
iv)	Operating mechanism	:	Universal Motor operated, trip free & anti pumping device
v)	Number of auxiliary contacts	:	6 NO + 6 NC
vi)	Rating of auxiliary contacts	:	10A at 240V AC
vii)	Temperature rise	:	As per IS: 13947
viii)	Mechanical life	:	As per IS: 13947
ix)	Operating mode	:	Local and Remote with auto manual facilities

3. Moulded Case Circuit Breakers (MCCBs) Draw out type

i)	Voltage	:	3 phase, 415V ± 10 %
ii)	Frequency	:	50 Hz ± 3%
iii)	Short Circuit performance category	:	P2
iv)	Operating mechanism	:	Manual, trip free
v)	Number of auxiliary contacts	:	6 NO + 6 NC
vi)	Rating of auxiliary contacts	:	10A at 240V AC
vii)	Temperature rise	:	As per IS / IEC
viii)	Mechanical life	:	As per IS / IEC

4.	Miniature Circuit Breakers (MCBs)		:	Draw out type
	i)	Voltage	:	240V ± 10 %
	ii)	Frequency	:	50 Hz ± 3%
	iii)	Short Circuit performance	:	P2 Category
	iv)	Operating mechanism	:	Manual trip free
	v)	Temperature rise & Mechanical life	: :	As per IS / IEC
5.	HRC fuses		:	As per IS/IEC
6.	Meters			
	i)	Accuracy Class	:	1.0
	ii)	One minute power frequency withstand voltage	:	2.5kV rms
7.	Current Transformers			
	i)	Type	:	Cast resin, primary bar type
	ii)	Secondary current	:	5A & 1A.
	iii)	Voltage class and frequency	:	650V, 50 Hz
	iv)	Class of insulation	:	B or better
	v)	Accuracy class and burden	:	
		a) Accuracy class (metering CT)	:	Class 1, VA adequate for application but not less than 15VA
		b) Accuracy class (protection CT)	:	5P, VA adequate for specific application but not less than 15VA
		c) Accuracy class (protection CT)	:	PS
	vi)	Short circuit current	:	50 kA for 1 sec.

vii) Short circuit breaking & making current : 2.5 times of the short circuit rating

8. Voltage Transformers

i) Type : Cast resin

ii) Rated voltage

a) Primary ` : 415 / √3 V

b) Secondary : 110 / √3 V

iii) Accuracy class

a) Metering : 1.0

b) Protection : 3P

iv) Method of connection

a) Primary ` : Star

b) Secondary : Star

v) Rated voltage factor : 1.1 continuous, 1.5 for 3 secs.

vi) Class of insulation : B or better

vii) One minute power frequency withstand voltage : 2.5kV (rms)

9. Relays :

i) One minute power Frequency withstand voltage : 2.5kV (rms)

20.7 SPECIFIC REQUIREMENTS FOR 0.415KV SWITCHGEAR EQUIPMENTS

The 0.415kV AC system consists of 0.415kV switchgears, connected with the respective station auxiliary transformers 11/0.433kV or unit auxiliary transformers 13.8/0.433kV.

The metal clad switchgear with incoming ACB shall be made with the busduct feeding from the respective dry type unit auxiliary or station

auxiliary transformers located in the common front with respective switchgear. Interface of metal clad switchgear and dry type transformers shall be under the scope of this specification.

Various panels forming part of the switchgear including dry type transformer at two ends of switchgear when assembled at site shall be of appearance of the continuous unit with flush appearance at the front without projections. It shall be unit type in construction. The design of the switchgear should be such that it gives a pleasing appearance, is compact in size and facilitates inspection and easy maintenance. The centre line of switches, push buttons, indicating lamps etc. and top line of instruments and relays etc. shall be matched to give a neat and uniform appearance. Necessary electrical clearances shall be maintained between live parts as well as live and earthed parts.

Adopter panels and dummy panels required to meet the various bus bar arrangement for connection between transformers and switchgear busbars shall be included in Tenderer's scope of work.

The dry type unit and station auxiliary transformers mounted in the cubicles and 0.415kV switchgear shall form a common panel board. Since the transformers are located near the inlet cubicles, the LT terminal of the transformers and switchgear buses shall be connected with copper buses inside the cubicles through seal off bushings. All accessories for connection with transformers shall be supplied by switchgear supplier. The supplier of LT switchgear shall coordinate with the supplier of dry type transformers for connections of the switchgear to the transformers.

20.7.1 Bus Bars and Support Insulators

20.7.1.1 The AC switchgear/board shall be provided with three phase and a neutral (TPN) bus bar system.

20.7.1.2 All the bus bar sections and jumper connections shall be made of high conductivity aluminium / aluminium alloy conductor of adequate size. The 415 volts aluminium bus bars shall be rectangular in cross section so as to be able to carry the required current within the limits of temperature rise at the site conditions. They shall be so designed and mounted in the chamber such that expansion or contraction does not effect either the bus bars or the insulating supports to any undue stresses. The bus bars shall be designed to withstand safely the dynamic forces due to short circuit. The size of neutral bus bar shall be 50% of phase bus bar and shall run continuously in the bus bar chamber and shall be connected at one point through disconnectable link to ground bus. Phase and neutral links shall be provided for individual feeders.

20.7.1.3 The cross section of the bus bars shall be uniform throughout the length of the switchgear/board and shall be adequately supported and braced to withstand the stresses due to the specified short circuit current.

20.7.1.4 All bus bars shall be adequately supported by Non-hygroscopic, non-combustible, track-resistant and high strength type polyster fibre glass moulded insulators/epoxy insulators. Separate supports shall be provided for each phase and neural bus bar. If a common support is provided, anti tracking barriers shall be provided between the supports.

20.7.1.5 All bus bar joints shall be provided with high tensile steel bolts, belleville/spring washers and nuts, so as to ensure good contacts at the joints. Non-silver plated bus bar joints shall be thoroughly cleaned at the joint locations and suitable contact grease shall be applied just before making a joint.

20.7.1.6 All bus bars shall be colour coded as per IS: 375.

20.7.1.7 The bidder shall furnish calculations alongwith the bid, establishing the adequacy of bus bar size for specified current ratings. The same shall also be furnished during detail engineering for the approval of purchaser.

20.7.1.8 Auxiliary buses shall be provided for AC and DC control power supplies. The material for all auxiliary buses for control power supplies shall also be of high conductivity aluminium. The supply for AC auxiliary buses shall be tapped from the main power buses before the incomer for each switchboard. Individual fuse and neutral links shall be provided at each circuit of AC auxiliary bus bar. The circuit for control, space heater & cubicle light should include an isolating miniature circuit breaker (MCB) too. The auxiliary bus bar compartment shall also run horizontally.

20.7.1.9 The bus bars shall be provided with at least minimum clearance in air as specified in IS: 4237 for a 500V, 3 phase 4 conductor system.

20.7.2 Air Break Circuit Breaker (ACB)

20.7.2.1 The circuit breaker shall be triple pole, draw-out type and shall have inherent fault current breaking and making capacity as specified in clause 20.6 'TECHNICAL DATA & RATINGS".

20.7.2.2 Air Circuit breakers shall be mounted alongwith its operating mechanism on telescopic rails. The cradle should be designed and constructed so as to permit the smooth withdrawal and insertion of the breaker into it. The movement shall be free of jerks and shall preferably be on rollers and not on the flat surface. Suitable guides shall be provided to minimize the misalignment of the breaker.

20.7.2.3 All the three poles of the circuit breakers shall operate simultaneously in such a way that the maximum difference between the instants of contacts touching during closing shall not exceed half cycle of rated frequency.

20.7.2.4 The main contacts shall be appropriate copper and silver plating of the faces shall be 25 micron.

20.7.2.5 Arcing contacts should be of tungsten/graphite base alloy and must be separate from main contacts. One piece butt type contacts shall not be acceptable.

20.7.2.6 The ACB cubicle shall have door interlocking facility so that the cubicle door cannot be opened when the ACB is closed or in "Test" position. However interlock defeat arrangement shall also be provided. Inbuilt interlock should be provided to prevent the closed circuit breaker being inserted into the panel.

20.7.2.7 The ACB shall have provision of locking it in isolated position for keeping personnel and equipment safe during maintenance.

20.7.2.8 Automatic safety shutters shall be provided to ensure that the cradle terminals are completely covered when the circuit breaker is draw out position. Complete removal of the breaker from the switchgear panel/board shall be simple and smooth. When the cubicle door is closed, the breaker shall be able to achieve three different positions "SERVICE/ISOLATED/TEST POSITION".

20.7.2.9 An auxiliary switch with 6 NO and 6 NC contacts shall be provided with each breaker and wired up to terminal block.

20.7.2.10 Air Circuit breaker shall be provided with motor operated spring charged mechanism. The motor shall be a universal motor suitable for operation from 240 ± 10% V AC. The charging time for closing springs shall not be more than 30 seconds. After failure of power supply, at least one open-close open operation shall be possible. Provision shall be made for emergency manual charging of closing spring.

20.7.2.11 Air circuit breakers shall be provided with closing and tripping coils. The closing coil shall operate correctly for voltage variation between 85% to 110% and trip coil for voltage variation between 70% & 110%.

20.7.2.12 Mechanical tripping shall be possible by means of front mounted red coloured trip push button. These push buttons shall be shrouded to prevent accidental operation.

20.7.2.13 Air circuit breaker shall be provided with mechanical indicating devices to show OPEN, CLOSE, TEST and SPRING CHARGED conditions.

20.7.2.14 Air circuit breaker shall be provided with no voltage release as it may be necessary to fulfill operation logic requirement.

20.7.3 Moulded Case Circuit Breakers (MCCB)

20.7.3.1 All the outgoing feeders (except where specifically mentioned) shall be provided with Moulded Case Circuit Breakers (MCCBs) having suitably designed for thermal over load and magnetic short circuit protection.

20.7.3.2 The MCCBs shall be mounted in a trolley which shall be of draw out type/plug- in type. The draw out mechanism for MCCBs shall be such that it shall be held in the cradle made of welded steel by means of two telescopic rails on which it shall be supported. These rails shall slide over ball bearings which shall make the movement of the MCCBs on the cradle extremely smooth.

20.7.3.3 MCCBs shall be manually operated. The operating handle should give a clear trip indication.

20.7.3.4 The MCCBs shall be quick make/quick break, trip free and independent of manual speed for operation.

20.7.3.5 MCCBs shall be fitted with direct acting magnetic thermal release for short circuit and overload protections. Settings of the thermal release shall be independently adjustable over a wide range of nominal rating in all ranges.

20.7.3.6 The MCCBs shall have a short circuit breaking capacity as given in clause 20.6.2 "TECHNICAL DATA & RATINGS".

20.7.4 Miniature Circuit Breakers (MCBs)

20.7.4.1 Miniature circuit breakers shall be designed in accordance with the requirements of IEC: 947.

20.7.4.2 MCBs shall be of double pole quick make and quick break type having both thermal over load and magnetic short circuit tripping devices with trip free mechanism. The contacts of MCBs shall be made of high corrosion and arc resistant material with silver layers to increase the life. It shall have non-ignitable, high impact plastic or fibreglass reinforced polyamide, precision moulded housing with universal surface suitable for flush mounting. Suitable arc chutes should be provided for quenching the arc in minimum time. The mechanism of the MCBs should not be influenced by environmental conditions. The MCBs shall have high rupturing capacity of not less than 10kA at 220V D.C. & 240V A.C. The tripping time on short circuit shall be less than 5 ms. Tripping characteristics of MCBs shall be submitted alongwith the bid.

20.7.5 Power Cable Terminations

20.7.5.1 LT power cables shall be taken out either from bottom or top of the switchgear panels in case of double front panels and either from bottom, rear or top of the switchgear panels in case of single front panels. Decision to this effect shall be taken at the time of final engineering of the drawings keeping in view of the blockouts already left in the layout floors. Purchaser reserves the right to alter the cable entries; if required during detail engineering, without any additional commercial implication.

20.7.5.2 Cable termination compartments and arrangement for power cables shall be suitable for stranded aluminium conductor, armoured/unarmoured PVC insulated and sheathed, single core / three and half core, 1100V grade power cables.

20.7.5.3 All necessary cable terminating accessories such as gland plates, supporting clamps and brackets, hardware etc. for puchaser's cables shall be provided by the bidder, to suit the final cable sizes which would be advised later.

20.7.5.4 The gland plate shall be of removable type and shall cover the entire cable alley. Bidder shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory drilled according to the cable gland sizes and number which shall be informed to the supplier during detail engineering. For all single core cables, gland plates shall be of non-magnetic material.

20.7.5.5 Heat shrinkable sleeve on horizontal bus bars shall be provided but not in vertical bus bars.

20.7.6 Power Sockets / Portable Equipment Outlets

20.7.6.1 Three phase power sockets with grounding terminal for 400A, 250A, 150A, 63A & 32A have been envisaged for supply of power to portable equipment.

20.7.6.2 Power sockets shall be supplied with the fuse & switch as well as set of extension with flexible cable of the respective section.

20.7.6.3 The power sockets shall be with protection class IP 54 according to IEC 529.

20.7.6.4 The type of plug and socket for the power socket networks shall be as being specified by contractor of portable equipment and by the purchaser. The detail of such sockets shall be specified during detail engineering.

20.7.7 CONTROL CIRCUITS

Control circuits of incoming and sectionalized circuit breakers shall be provided with 220V DC.

Miniature circuit breakers with alarm contact for remote indication of tripped condition shall be provided for protection of the control circuits. The MCBs shall be of the fixed type for mounting on DIN rail. All means shall be provided for easy removal and handling of MCBs.

All MCBs shall be provided with necessary quantity of potential free contacts for specified indications, alarms and interlocks. All auxiliary contacts shall be wired to terminal blocks in the cable compartment.

Control switches for following control functions shall be provided for each incoming and sectionalized circuit breakers:

1. Local/remote mode of operation
2. Test-Normal-Close selector switch with pistol grip handle and key interlock for circuit breaker
3. Manual Open/Close operation
4. On/Off automatic change over unit

Auxiliary contacts for following remote indications shall be wired to terminal blocks:

1. Local/remote control mode selection
2. Test and connected position (each withdrawable assembly)
3. Circuit breaker trip condition (each withdrawable assembly)
4. Circuit breaker position (each withdrawable assembly)

20.7.8 METERING

All measuring equipment shall be located in the respective circuit breaker compartment. All metering circuits shall be terminated on marked terminal blocks for remote metering purpose. All meters, indicators control and selector switch shall be located in hinged door of this compartment.

On the door of switchgear are located:

1. One bimetal/moving iron movement ampere meter with selector switch for all incoming feeder.
2. One current transducer on all incoming feeder.
3. One voltmeter with selector switch for all incoming switch.

4. Voltage transducers for incoming and bus voltage.
5. One active energy meter for all incoming feeder s in draw out cases with built in test facilities alternatively, these may have test block to facilitate testing of meter without disturbing CT or VT secondary connections. Active energy meters shall also have remote output.

Motor ammeter wherever required shall have an extended suppressed end-scale range to indicate starting current (5 to 8 times full load current)

Current measurements

Current transformers shall be mounted in the compartment with their respective feeder. Secondary leads of the current transformers shall be connected to marked terminals in the cable compartment in each cubicle. Secondary windings shall be earthed at one point only and means shall be provided on the equipment to facilitate the secondary circuit of the CTs being short circuited in the terminal blocks.

Voltage measurements

The secondary leads of the VTs shall be connected to MCBs with alarm contacts and wired to terminals. The secondary winding shall be earthed at one point only.

20.7.9 CUBICLES

The switchgear shall be indoor, air insulated, metal clad, floor mounting draw-out type, dust and water proof with vermin protection.

Switchgear enclosure shall confirm the degree of protection IP-54 according to the IEC 529. The minimum thickness of sheet metal used shall be 2mm. cubicles shall be in accordance with the recommendations of IEC 439.
The design shall be fully compartmentalized with metal/insulating partitions. The switchgear shall be comprise a continuous line up of single/multi tier cubicles. The installations of air circuit breaker at switchgear however shall be limited to the bottom two tiers only. All doors and covers shall be gasketed. All switchgear frames shall be fabricated using suitable mild steel structural sections or pressed and shaped with Cold rolled sheet steel of thickness not less than 2mm. doors and covers shall also be of Cold rolled sheet steel of thickness not less than 2mm. Stiffeners shall be provided ,wherever necessary. The panel shall be designed taking into account seismic effect of this area.

All panels edges and cover/door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement member. The complete structure shall be rigid, self supporting free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.

Each cubicle shall have hinged door. The hinged doors shall be such as to allow the withdrawable type breakers to withdrawn to "Test" & "Isolate" position without opening the door and shall be interlocked so that it can not be opened unless the breaker is "Off" & "Isolate" position. It shall also not be possible to rack the breaker into service position unless the door is closed.

The switchgear shall be provided with supporting frame work and foundation bolts etc. to have proper leveling, additional channel iron frame of size 75mm x40mm x6mm for embedment in the floor concrete shall be supplied along with suitable size of foundation bolts. It shall be designed in such a way that switchgear when placed on the embedded frame and bolted, shall require no further fastening. The panels shall be fixed on the embedded foundation channel with provision to with stand earthquake with ground acceleration of 1.0g.

20.7.10 CURRENT TRANSFORMER

The current transformer shall be provided wherever specified. The CTs shall be designed and tested to comply in all respects to IS: 2705/IEC44-1 with latest amendments/additions.

The CTs shall be of the single phase, single/multi core, dry completely encapsulated cast resign insulation type. The CTs ratings shall be in accordance with general requirements, and the following additional requirements.

The secondary current of the CTs shall be 5A throughout. The capacity of each CT shall be chosen by the Contractor to suit the requirements of the connected apparatus and device, but shall not be less than 125% of the overall computed load on each core.

Other technical requirements/characteristics for different CTs have been indicated in Schedule of requirements/schematic drawings appended with these specifications.
These shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the system. The core laminations shall be of high grade silicon steel. The maximum currents shall be as low as possible.

CTs shall have polarity marks indelibly marked on each transformer and at the lead terminations at the associated terminal blocks. Facility shall be provided for short circuiting and grounding the CT secondary at the terminal blocks. Characteristic curve for CTs are to be furnished by successful tenderer. It will be the responsibility of successful tenderer to match the CT characteristics of differential, REF CTs with those provided on LV side.

All secondary connections shall be brought out to terminal blocks where star or delta connection will be made.

Accuracy class of CTs shall be:
- Class PS for Differential (For incomer from transformer only)
- Class 5P20 for other relaying
- Class 1.0, ISF<5 for metering

20.7.11 VOLTAGE TRANSFORMER

The voltage transformers shall be designed and tested in accordance with IEC: 186/IS: 3156 (Latest revision). The VTs shall be of single phase, completely encapsulated cast resign insulated dry type transformers suitable for continuous operation at the temperature prevailing inside the switchgear enclosure when the switchgear in operating condition and the outside ambient temperature is 40 degree C.

The VTs ratings shall be in accordance with general requirements, and the following additional requirements.
- Primary Voltage 415/√3 V
- Secondary Voltage, for metering 110/√3 V
- Winging to be used for metering accuracy class 1.0

The capacity of the voltage transformers shall be chosen by the contractor to suit the requirements of connected apparatus and devices, but shall not be less than 125% of the overall computed burden of the apparatus connected to the respective winding. Vt mounted on breaker carriage is not acceptable.

High Voltage windings of VT shall be protected by current limiting fuse. The VT and fuses shall be completely disconnected and visibly grounded in fully draw-out position.

Low voltage fuses, sized to prevent overload, shall be installed in all ungrounded secondary loads. Fuses shall be suitably located to permit easy replacement while the switchgear is energized.

20.7.12 RELAYS

The protection and control relays shall be designed in accordance with the recommendations of IEC 255/IS: 3231, 8686 & BS: 142 and shall be suitable for operation under climatic conditions prevalent at site.

All relays may be of draw-out design with built in testing facilities. Small auxiliaries' relays may be of non draw-out type. Necessary test plugs shall be supplied loose and shall be included in contactors scope of supply.

Relays shall be rated for operation on 5A secondary current and 110V secondary voltage, number and rating of relays contacts shall suit the job requirements.

The contactor shall furnish, install and coordinate all relays to suit the requirement of protection, interlock and bus transfer scheme as broadly indicated in the annexure and drawings.

The contacts of all relay shall be capable of marking the maximum current which may occur in the circuit which they have to control. They shall also be capable of breaking such currents unless provision is made for breaking the current on contacts elsewhere in the circuit. Relays shall be affected by mechanical shock or vibration or by external magnetic fields consistent with the place or method of mounting. All relays which are connected to complete the tripping circuit of circuit breaker or the operating coil of ma tripping relay shall be provided with operation indicators.

On relay elements indicators shall also be provided to enable the type or phase of the fault condition to be identified. Each indicator, whether of the electrically or mechanically operated type, shall be capable of being reset by hand without opening the relay case. Each indication shall be so designed that it can not be move before the relay has completed its operation, shall be clearly visible from the front when operated and shall be concealed at all other items. It shall not be possible to operate any relay by hand without opening the case.

All protective relays which initiate tripping shall have not less than two independent pairs of contacts of which one shall operate the tripping relays directly without the use or interposition of auxiliary contactors.

Relay having elements associated with particular phases shall be marked with phase identifications. The relay elements associated with phases R, Y & B or equivalent shall be mounted respectively left to right or top to bottom when viewed from front.

All relays shall be suitably marked with the following information:

a) Phase colour of the current and / or voltage supply
b) Function of relay e.g. over current.
c) Rated current and/or voltage of the relay coils.
d) Characteristic curve, where appropriate.

Space for client's reference marking item a) to c) shall be visible from the front without removing the cover.

In order to eliminate the effects of electrolysis, DC operating coils shall be so placed in the circuit that they are not connected to the positive pole of the battery supply except through contacts which are normally open. Auxiliary relays shall have sufficient number of pairs of contacts as required to complete the scheme. Contacts shall be silver plated with spring action. Relay cases shall have adequate number of terminals for marking potential free connections to the relay coils including spare contacts. Relay case size shall be so chosen as not to introduce any limitations on the use of available contacts of the relay due to inadequacy of terminals. Paralleling of contacts, if any, shall be done at the terminals on the casing of the relay.

Tripping relays shall be designed for the DC voltage specified and shall operate satisfactorily between 50% & 120% of the rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

Timers shall be of the electromagnetic or solid state type but pneumatic timers are not acceptable. Short time delay in terms of milli-seconds may be obtained by using copper lugs on auxiliary relays and in such cases it shall be ensured that the continuous rating of the relay is not affected. Time delay in terms of milli-seconds obtained by external capacitor resistor combination is not preferred and shall be avoided to the extent possible. All timers shall be provided with externally hand reset positive action operation indicators.

No control relays which shall trip the power circuit breaker when the relay is de-energized shall be employed in the circuits. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

All relays shall withstand a test voltage of 2KV, 50 Hz RMS voltage for one minute.

Auxiliary seal in units provided on the relays shall preferably be of shunt reinforcement type.

Indication lamps should be located just above the associated push buttons/control switches. Red lamps shall invariably be located to the right of green lamps.

In case a white lamp is also provided, it shall be placed between the red and green lamps along the center line of control switch/push button pair. Blue and amber lamps should normally be located above the red and green lamps.

When associated with push buttons, red lamp shall be directly above the green push button and green lamp shall be directly above the red push button. All indicating lamps shall be suitable for continuous operation at 90 to 110% of their rated voltage.

All auxiliary relays with sufficient number of contacts for completion of the scheme, timer trip relays, indicating lamps, switches etc. for satisfactory operations of the equipment form local as well as from remote shall be included whether specified or not specified.

Relays may be direct acting or CT operated, depending on current rating.

20.7.13 METERS

The metering instruments shall be manufactured in accordance with IEC 51/IEC 473, IS: 1248/722.

All instruments and meters shall be suitable for operation under the climatic conditions prevailing at site. The instruments cases shall be dust proof, water tight, vermin proof specially constructed to adequately protect the instrument against damage or deterioration due to high ambient temperature and humidity.

Metering instruments shall be of the long scale 270^0 dial type with black graduations and numerals on a white back ground and antiglare glass. Frame dimensions shall be 96mmx96mm. Instruments mounted on panels shall be back connected. All instruments on a switch board or instrument panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements. The finish of the instrument case shall be subject to the approval of Owner.

The VA burden of the instrument coils shall be as low as possible consistent with best modern design.

Error shall not exceed 2% reckoned on the total length of the scale. Moving elements shall be provided with zero adjustments readily accessible from the front. The ampere-and voltmeters shall be able to handle 20% continuous overload. The Contractor shall submit scale, markings and name plates of all instruments for approval.

Ammeters and current coils of watt-meters shall continuously withstand 120% of rated current and 20 times rated current for 0.5 sec. without loss of accuracy. Voltmeters and potential coils of watt-meters shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 sec. without loss of accuracy. Selector switch for each ammeter and voltmeter shall be provided to select current of each phase and phase to phase voltage respectively.

Motor ammeter shall have an extended suppressed end scale range to indicate starting current (5 to 8 time full-load current).

Watt-hour meter shall be provided in draw out cases with built-in test facilities. Alternatively, they may have test block to facilitate testing of meter without disturbing CT or VT secondary connections. Watt hour meter for the incoming feeders shall have pulse remote output for connecting to the energy metering system.

20.7.14 INDICATING LAMPS

The indication lamps shall be manufactured in accordance with IEC 947-5-1.

Indicating and signaling lamps shall be suitable for use in respective panels in accordance with the voltages used for signaling. Each lamp shall have a removable cap, which can be inscribed with text and shall be softened by the heat of the lamp.

Lamps shall be low-watt, filament type with series resistor and colored lens. Lens and lamps shall be replaceable from the front.

The lamp holders shall be suitable for panel mounting and rear terminal connections. All lamps on AC/DC as the case may be, shall be of the same type and design. Lamps shall have translucent lamps covers to diffuse light in required colours as described below. Each lamp holder shall be fitted with black inscription plate having white engraved letters.

Red	:	ACBs/MCCBs/MCBs close
Green	:	ACBs/MCCBs/MCBs open

White	:	Auto trip
Amber	:	For all healthy conditions e.g. control supply.
Violet	:	Circuit breaker spring charged.
Blue	:	For all alarm conditions (e.g. over load) Also for "SERVICE" & "TEST" position indicators.

20.7.15 CONTROL SWITCHES, PUSH BUTTONS AND OTHER ACCESSORIES CONTROL AND SELECTOR SWITCHES

The switching elements shall be manufactured in accordance with IEC 947-5-1

Selector and control switches shall be of rotary type. The switches and pushbuttons shall be provided with ample contact stages, suitable cam or block arrangement necessary for the control system functions.

Momentary switches shall be rotary buttons of the spring return type or push buttons.

Switches shall be suitable for use with 240V AC or 220V DC control voltage.

Circuit breaker control switches shall have three positions and shall be spring return to "NEUTRAL" from "CLOSE" and TRIP" positions and shall have pistol grip handles. They shall have at least two contacts closing in close position, and two contacts closing in trip position unless specified otherwise.

Ammeter and voltmeter selector switches shall have four stay-out positions with adequate number of contacts for three phase 4 wire system. These shall have oval handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondaries. Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

Make and carry continuously current rating of the contact shall be at least 10 Amp.

PUSH BUTTONS

Push buttons shall be of spring return, push to actuate type. Their contacts shall be rated to make continuously carry and break 10A at 240V AC and 0.5 A at 220V DC.

All push buttons shall have one normally open and one normally closed contact, unless specified otherwise. The contact faces shall be of silver or silver alloy.

All push buttons shall be provided with integral escutcheon plates marked with its function.

The colour of the button shall be as follows:

Green	:	Breaker Close
Red	:	Breaker Open
Black	:	For Overload reset.

HRC FUSES

HRC-Fuses shall have visible operation indicators.

HRC-Fuses shall be mounted on fuses carriers, which are mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug in type of bases. In such cases one set of insulted fuse pulling handles shall be supplied with each switchgear.

HRC-Fuses rating shall be chosen by the tenderer depending upon the circuit requirements and these shall be subject to approval of Owner.

20.7.16 CONTROL AND SECONDARY WIRING

415V SG shall be fully wired at the factory to ensure proper functioning of control, protection, transfer and interlocking scheme. All SGs shall be supplied completely wired internally upto the terminal blocks ready to receive all inter-cubicle and inter panel wiring and connections between panels of same SG including all bus wiring for AC and DC supplies shall be provided by the tenderer.

Provision of remote “ON” & “OFF” indications of each ACB and MCCB shall be provided in the distribution boards.

Extra flexible wires shall be used for wiring to devices mounted on moving parts such as hinged doors.

All wiring shall be properly supported, neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks.

Internal terminations of stranded conductors shall be made with solder less crimping type tinned copper lugs which shall firmly grip the conductor, or by an equally suitable method. Insulating sleeve shall be provided over the exposed parts of lugs.

Suitable fuse and links/MCBs shall be provided to permit individual circuit isolation from bus wires without disturbing other circuit. All spare contacts of relays, switches and other devices shall be wired upto terminal blocks.

All internal wiring shall be done with flexible, 650/1100V grade, single core having colour coded PVC insulated switchboard wired with stranded copper conductors 2.5 mm^2 for control circuit, 4 mm^2 for VT circuits and 6 mm^2 for CT circuits.

Each wire shall be identified at both ends with Permanent markers bearing wire numbers as per Contractor's wiring diagram.

Wire termination shall be made with crimping type connectors with insulating sleeves. Wire shall not be spliced between terminals.

20.7.17 CABLE TERMINATIONS

LT power cable s shall be taken out either bottom or top of the SG panels. Cabling chamber, cabling termination compartment of adequate size shall be provided at the rear /front of the SG for proper accommodation of incoming /outgoing cables.

Cable termination compartment and arrangement for power cable shall be suitable for stranded aluminium conductor, PVC insulated and sheathe, singe core/three & half core unarmoured, 1100V grade power cable.

Cabling chamber should be so located and spaced so that it shall be possible to bring the cables direct through cut-out in floor. Cables termination shall be such that no cable bent is required in the cable chamber. Cut-outs shall not be available where there are RCC beams and the design of Switchgear shall be take care of this constraint. Bimetallic terminal connectors shall be used wherever required to avoid electrolytic effect.

The gland plate shall be removable type and shall cover the entire cable alley. Tenderer shall also ensure that sufficient space is provided for all cable glands. Gland plates shall be factory drilled according to the cable gland size and number which are indicated in the enclosed specification drawings.

However, the exact sizes and number shall be confirmed during detail design stage. For all single core cables, gland plates shall be of non magnetic materials.

The outgoing feeders shall be so arranged that heavy size cables are terminated preferably in the middle portion of the panel (height wise) to provide the space for fixing of cables and easiness of handling.

20.7.18 AC/DC POWER SUPPLY

The following power supplies shall be made available to each SG:
AC supply: from different SG sections with Change over unit
DC supply: Double feeder

Isolating switch fuse unit shall be provided at each SG for the incoming supplies, 4-pole, single throw for AC and 2-pole, double throw for DC.

Bus wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles. Isolating switch fuse units shall be provided to each cubicle for AC/DC supplies.

AC load shall be so distributed as to present a balance loading on the three phase supply system.

20.7.19 TROPICAL PROTECTION

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent the entrance of insects.

20.7.20 PAINTING

All steel surfaces shall be sand blasted, grounded and picked as required to produce a smooth, clean surface free of scale, grease & rust.

After cleaning the surfaces shall be given a phosphate coating following by two coats of high quality primer and stoved after each coat.

ALL SGs/MCCs shall be finished in light grey shade No. 631 of IS: 5 (1961) with two coats of synthetic enamel paint. The base frame at the bottom of panel shall have store enamel grossy black finish. Sufficient quantity of touch-up paint shall be furnished for application at site.

To prevent the panel surfaces from scratches during handling, transportation and erection at site, a thin light coat of peel off paint will be applied. Thos film of peel off paint will be removed after commissioning of panels at site.

20.7.21 INTERLOCKING SCHEME

20.7.21.1 Precaution to be adopted in Interlocking Scheme

While adopting the fault current rating of the different equipments in the switchgear panels / boards, it has been envisaged that all the power supply sources shall be independent and necessary interlocks shall be provided in the circuit so that these sources cannot supply power to bus bars simultaneously. This safety of operation shall be ensured by proper interlocking.

Interlocks shall be provided in the closing circuits of the air circuit breakers by 86 relay which shall be hand reset type and will not close the contacts till the fault persists in the circuit.

20.7.21.2 Interlocking Scheme of LT Switchgears/Boards Installed in Power House Cavern, Transformer cavern & Pothead yard

The single line diagram of 415 V LT switchgears / boards for power house caverns comprising of 4 UABs (UAB-1 to 4) and 7 SABs is shown in drawing in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". The interlocking and automatic change-over scheme of the main incomer breakers and sectionalizing / tie breakers, to maintain continuous LT power supply, is described in the following paragraphs and it is the responsibility of the bidder to adhere to this for achieving the desired results. Bidder shall get the interlocking drawing approved from the purchaser. The necessary schematic to this effect shall be fixed on each panel.

20.7.21.2.1 Unit Auxiliary Switchgears / Boards (UAB-1 to 4)

Initially at the time of starting of the unit, the unit auxiliary switchgear panels / boards (UAB-1 & 2) shall receive LT power from SAB-4 and (UAB-3 & 4) shall receive LT power from SAB-2. After the unit is synchronized with the grid, which can be ascertained by auxiliary contacts of the respective generator circuit breaker, the LT supply to respective unit auxiliary switchgear / board shall be met through 400 kVA, 11/0.433 kV unit auxiliary transformers. There should be interlocking between breakers i.e. at one time only either of the two

breakers can be switched "ON". Reverse sequence is to be followed, when desynchronizing of the unit takes place.

The logic of Automatic change-over of sources of power supply to UAB is as follows:

When the unit is standstill the unit auxiliary switchgears / boards UAB (1 to 4) are fed power by the station auxiliary switchgear / board (SAB-2 & 4). In the case of UAT-1

- The incomer circuit breaker from UAT-1 is switched-off.

- After that incomer circuit breaker from SAB-4 is switched-on.

When the unit is synchronized with the grid and UAT-1 is energized

- The incomer circuit breaker from SAB-4 is switched-off.

- After that incomer circuit breaker from UAT-1 is switched-on.

When the unit is given shut-down signal in normal condition or there is a fault in the UAT-1 and there is no voltage on output terminals of UAT-1, in this case

- The incomer circuit breaker from UAT-1 is switched-off.

- After that incomer circuit breaker from SAB-4 is switched-on.

The above interlocking scheme may be adopted for all the four unit auxiliary switchgears / boards.

20.7.21.2.2Station Auxiliary Switchgears / Boards (SAB-1, SAB-2 & SAB-3)

The switchgears SAB-1 and SAB-3 will get LT supply from SAB-2 through TPN bus-duct and normally closed circuit breakers. The SAB-2 will get LT supply from 1600 kVA**,** 11/0.433 kV station auxiliary transformers SAT-1 and SAT-2 through circuit breakers. SAB-2 is also supplying the LT power to UAB-3 & 4.

The logic of Automatic change-over of LT power supply sources to SAB-1, SAB-2 & SAB-3 shall be as under:

SAB-1 & SAB-3 have normally closed type of ACBs for incoming and outgoing feeders and have no emergency feeders; therefore these switchgears have not been provided with special interlocking system. The interlocking scheme for SAB-2 is described below.

Under normal operating conditions the station auxiliary switchgear SAB-2 will receive L.T. power supply from SSB-1 through two 1600 kVA, 11/0.433 kV, dry type, station auxiliary transformers (SAT-1 & SAT-2)

When both the 1600 kVA, 11/0.433kV station auxiliary transformers SAT-1 & SAT-2 are in healthy condition, power supply shall be fed from both incomers to different sections of SAB-2 with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.2.3Station Auxiliary Switchgear / Board (SAB-4)

The switchgear SAB-4 will get LT supply from SSB-1 through 1250 kVA, 11/0.433 kV station auxiliary transformers SAT-3 and SAT-4 through circuit breakers. SAB-4 is supplying the LT power to UAB-1 & 2.

The logic of Automatic change-over of LT power supply sources to SAB-4 shall be as under:
When both the 1250 kVA, 11/0.433kV station auxiliary transformers SAT-3 & SAT-4 are in healthy condition, power supply shall be fed from both incomers to different sections of SAB-4 with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.2.4Station Auxiliary Switchgear / Boards (SAB-5)

0.415kV LT power required in transformer hall cavern shall be fed from SAB-5. The switchgear SAB-5 will get LT supply from two different sections of SSB-1 (Section 1 & 3) through 630 kVA**,** 11/0.433 kV station auxiliary transformers SAT-5 and SAT-6 through circuit breakers.

The logic of Automatic change-over of LT power supply sources to SAB-5 shall be as under:

When both the 630 kVA, 11/0.433kV station auxiliary transformers SAT-5 & SAT-6 are in healthy condition, power supply shall be fed from both incomers to different sections of SAB-5 with bus coupler in open

condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.3 Inter locking Scheme of Station auxiliary switchgears / Boards Installed out side of Power House

The single line diagram of 0.415 kV LT switchgears / boards for supplying LT power to the auxiliaries located in TRT area & potheadyard comprising of SAB-6, SAB-7 is also shown in Drg. in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". The interlocking and automatic change-over scheme of the main and stand-by incomer breakers to maintain continuous LT supply to these areas is described in the following paragraphs. However, the interlocking scheme to this effect shall be submitted during detail engineering for the approval of purchaser.

20.7.21.3.1 Station Auxiliary Switchgear / Board (SAB-6)

0.415kV LT power required in TRT outfall area shall be supplied by SAB-6. The power to SAB-6 shall be fed from Potheadyard through 11 kV over head bare ACSR feeders, SAT-7 & 8 and local 11 kV metal enclosed switchgear cubicle.

The logic of LT supply to SAB-6 shall be as under:

In normal case when both incoming feeders alongwith the 250kVA, 11/0.433kV station auxiliary transformers (SAT-7 & SAT-8) are in healthy condition, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be feed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.3.2 Station Auxiliary Switchgear / Board (SAB-7)

0.415KV LT power required in the pothead yard shall be supplied by 0.415 kV metal enclosed switchgear / board SAB-7. The power to SAB-7 shall be fed from SAT-9 & 10 through 11kV switchgear at Pothead yard (SSB-2).
The logic of automatic change-over of incomer / feeder breakers shall be as under:

When both 630 kVA, 11/0.433kV SAT-9 & SAT-10 are in healthy condition, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be feed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.4 Interlocking Scheme of Station Auxiliary Switchgears / Boards Installed at other sites

One independent LTAC scheme completely isolated from LTAC scheme of Power House have also been included under this specification for supplying LT power to the auxiliaries located at the Dam site, Desilting Chamber area & BFV/ Surge shaft area area. The single line diagram of above LT scheme comprising of LT switchgears / boards SAB-8, SAB-9 & SAB-10 are shown in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". The interlocking and automatic change-over scheme of main & standby incomer breakers to maintain continuous LT supply to these areas is described in the following paragraphs. However, the interlocking scheme being adopted by the supplier shall be furnished during detail engineering for the approval of purchaser.

20.7.21.4.1 Station Auxiliary Switchgear / Board (SAB-8)

0.415kV LT power supply to the auxiliaries installed at Dam site shall be met through LT metal enclosed switchgear / board SAB-8. The LT power to this SAB-8 will be fed from near by S/S to be constructed for construction power through 2 nos. 250 kVA, 11/0.433kV, cast resin dry type station auxiliary transformers SAT-11 & SAT-12.

The logic of automatic change-over of LT power supply sources to SAB-8 shall be as under:

In normal case when both incoming feeders alongwith the 250kVA, 11/0.433kV station auxiliary transformers (SAT-11 & SAT-12) are in healthy condition, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

Under emergency condition, when both incoming feeders supply are not available only then 400KVA, 415V DG (DG-III or DG-IV) set will be switched ON and power to all the essential services will be restored. The

operation of DG set shall be manual and there shall be no automatic switching ON of DGs in the event of failure of all the supplies. In the event of failure of both incoming supply only one DG set will be switched on and the other shall be in standby condition. Both the DGs shall never be switched on simultaneously.

20.7.21.4.2Station Auxiliary Switchgear / Board (SAB-9)

0.415kV LT power supply to the auxiliaries installed in and around Desilting chambers area shall be met through LT metal enclosed switchgear / board SAB-9. The LT power to this SAB-9 will be fed from near by S/S to be constructed for construction power through 2 nos. 250 kVA, 11/0.433 kV, cast resin dry type station auxiliary transformers SAT-13 & SAT-14.

The logic of automatic change-over of LT power supply sources to SAB-9 shall be as under:

In normal case when both incoming feeders alongwith the 250kVA, 11/0.433kV station auxiliary transformers (SAT-13 & SAT-14) are in healthy condition, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.21.4.3Station Auxiliary Switchgear / Board (SAB-10)

0.415kV LT power required in B.F.V. Chamber & surge shaft area shall be supplied by SAB-10. The power to SAB-10 shall be fed from near by S/S to be constructed for construction power through 2 nos. 250 kVA, 11/0.433 kV, resin cast dry type station auxiliary transformers SAT-15 & SAT-16.

The logic of Automatic Change-over of LT supply sources to SAB-10 shall be as under:

In normal case when both incoming feeders alongwith the 250kVA, 11/0.433kV station auxiliary transformers (SAT-15 & SAT-16) are in healthy condition, power supply shall be fed from both incomers with bus coupler in open condition. When there is fault in one of the incomer feeder then bus coupler breaker shall close and power supply shall be fed from 2nd incomer feeder. When power supply to feeder under fault condition is restored, then bus coupler will open and again power will be supplied through two independent feeders.

20.7.22 PROTECTIONS

20.7.22.1 The minimum protections to be provided for deferent types of circuits are listed below:

a) Incoming feeder 3-inverse time O/C relays (51) for phase fault
1- Inverse time O/C relays (51N) for earth fault
Restricted earth- fault protection (for LV station service transformer side only)

b) Outgoing feeder 2-inverse time O/C relays (51) for phase fault
1-inverse time O/C relays (51N) for earth fault
1-U /V Relay

c) Motor feeder 1-Motor protection relay (99) for protection against:
-Thermal overload
-Phase faults
-Unbalance (Negative sequence)
-Locked rotor
-Earth faults

20.7.22.2 Apart from protection relays, each electrically operated breaker shall be provided with anti-pumping (94), trip annunciation (30), lockout (86) and trip supervision (74) relays. Lockout relay shall be hand reset type. Protection indicated in drawing under Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement" is indicative. Protection scheme for LTAC system shall be finally decided during detail design stage.

20.7.22.3 Fuse failure relay shall be provided on secondary side of voltage transformer to monitor HV & LV fuses.

However, the bidder may suggest modifications to the 415 V station auxiliary schemes including Protections described as mentioned above.

20.7.23 REMOTE CONTROL & ANNUNCIATION PANEL

20.7.23.1 Only remote annunciation panel may be provided. No manual control of 415 V switchgears is required from control room. These switchgears shall have remote operation only from CCS. This annunciation panel may be made common for the entire power house where all information of all the units come alongwith the information of 415V switchgear. The manual controls are only from individual MCCs. However, emergency stop command of different feeders of MCCs may be provided on this panel if required.

It has been proposed to provide remote control, indications and annunciations etc. in the power house control room for the following equipment:

– 415 V incoming, interconnecting & outgoing air circuit breakers, moulded case circuit breakers, miniature circuit breakers

For ACB

- Annunciation for over current, earth fault, DC fail, No volt trip
- Indication & control for Breaker ON/OFF
- Metering –Ammeter, Wattmeter

For MCB & MCCB

- Annunciation for TRIP Indication
- Indication for ON & OFF
- Metering- Ammeter & wattmeter

For Bus

- Metering- Voltmeter, frequency

- Position & status of all the unit auxiliary, station auxiliary & station service transformers (indication & annunciation only)

20.7.23.2 The proposed remote control panel shall have ON / OFF / Fault trip, trip circuit healthy indicating lamps, close & open control push buttons, trip & non-trip alarm scheme.

20.7.23.3 The bidder shall furnish a complete schematic for ensuring complete remote control, indication / annunciation of aforesaid equipments.

20.7.23.4 The bidder shall furnish a complete list of the signals which are required for ensuring complete remote control, indication/annunciation of the aforesaid equipment with CCS and central alarm and annunciation panel to be supplied by other supplier.

20.7.23.5 The overall height of the remote control panel shall be as for the other switchgear panels.

20.7.23.6 Provision of remote "ON" & "OFF" indications of each ACB's, MCCB's and MCBs shall be provided in the switchgear cubicles / boards. Necessary control wiring from switchgear panel/board to RTU's for item numbers 1 to 11 in the schedule of requirement shall have to be carried out by the bidder. RTU's and optic fibre cable for this purpose shall also

be supplied by the bidder for remote control & monitoring of the LT Switchgear from remote control panel as well as from the operator station located in control room of power house.

20.7.24 AUTOMATIC CHANGE-OVER UNITS

The voltage control relay shall be designed in accordance with the recommendations of IEC 255.

The voltage control relays shall be for monitoring the 3 phase voltage. Characteristics of the voltage control relay shall be in accordance with the following requirements.

Rated voltage U_n	415 V AC
Adjustable upper voltage limit	0.75-1.05 Un
Adjustable lower voltage limit	0.15-0.30 Un
Adjustable reaction time	0.1-10 sec

In case of supply voltage drops to 80% or below on one of the section of SG (sensed by respective bus under voltage relay) and if such drop is not of transient in nature (to be checked by slave time delay relay to the above undervoltage relay) then the particular incomer breaker will trip automatically and such tripping shall be independent of any position of "On/Off automatic change-over" selector switch.

One (1) No. "On/Off automatic change-over" selector switch with two positions shall be provided on SG which would close the sectionalized circuit breaker automatically if:

- The "On / Off automatic change-over" selector switch in “On” position; Either of the two incomer breakers is open.

- The bus fault does not persist on unhealthy section of bus, the incomer breaker of which is open (to be checked by non-operation of lockout relay of corresponding incomer breaker).

- The voltage of the unhealthy section of bus is not more than 20% of the rated voltage and voltage of the other section of bus is more than 80% of rated voltage. (All these bus voltages shall be sensed by respective bus undervoltage relays, set at 20% and 80% settings)..

In case the automatic change-over does not take place within the present time (to be checked by slave time delay relay connected to 20% bus undervoltage relay) then all the outgoing motor feeder breakers of unhealthy section of bus shall be tripped due to undervoltage through lockout relay and auto changeover circuit. For closing the Bus coupler breaker shall also be blocked.

In this connection, it shall be specifically noted that tripping of all outgoing motor feeder breakers due to undervoltage shall be

independent of position selection of "On/Off automatic change-over" selector switch but shall be dependent on the sustained bus undervoltage condition ensured by time delay relay connected to 20% bus undervoltage relay.

The above changeover features shall be incorporated in the control schematics of incoming & sectionalized breakers.

20.7.25 Terminal Blocks

Terminal blocks shall be of 650 V grade rated for 10Amps and in one piece moulding. It shall be complete with insulating barriers, screw less cage clamp type/screw & stud type with identification strips. The latter type shall have screw locking design to prevent loosening of conductors under any severe conditions. Marking terminal strip shall correspond to the terminal numbering on wiring diagrams.

Terminal blocks for CT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary leads shall be provided with short circuiting and earthing facilities.

In all circuit breaker panels at least 20% spare terminals for external connections shall be provided and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminals shall also be available.

All terminal blocks shall be suitable for terminating on each side, two (2) nos. of 2.5mm^2 size stranded copper conductors.

All terminals shall be numbered for identification and grouped according to the function. Engraved white on black labels shall be provided on the terminal blocks.

Wherever duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminals blocks shall be arranged with at least 100 mm clearance between two sets of terminal block. The minimum clearance between the first row of terminal blocks and the associated cable gland plate shall be 250mm.

Self aligning, spring loaded, silver plated, sliding contacts of proven design shall be provided as control terminals for withdrawable/drawout modules. Detachable plug and socket type control terminals shall also be acceptable.

Terminal blocks shall be located to allow easy access. Wiring shall be so arranged that individual wires of an external cable can be connected to consecutive terminals.

20.7.26 Ground Bus

A ground bus of copper rated to carry maximum fault current, shall extend full length of the SG.

The ground bus shall be provided with two-bolt drilling with G.I bolts and nuts at each end to receive 60 x 10 mm GI flat.

Each stationary unit shall be connected directly to the ground bus. The frame of each circuit breaker and drawout V.T. unit shall be grounded through heavy multiple contacts at all times except when the primary disconnecting devices are separated by a safe distance.

Wherever the schematic diagrams indicate a definite ground at the SG a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.

C.T. & V.T. secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing others.

All hinged doors shall be earthed through flexible earthing braid.

All non-current carrying metal work of the distribution board shall be effectively bonded to the earth bus. Electrical conductivity of the whole distribution enclosure frames work and the truck shall be maintained even after painting.

The truck and air circuit breaker frame shall get earthed while the truck is being inserted in the panels and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. SERVICE & ISOLATED, as well as through out the intermediate travel.

Each module frame shall get engaged to the vertical earth bus, before the disconnecting contacts on the module are 'engaged to the vertical busbar.

All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth bus by independent stranded copper wires of size not less than 2.5 mm. sq. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering is not acceptable. Looping of earth connection is not acceptable which would result in loss of earth connections to other devices when a device is removed.

20.7.27 Name Plates

Nameplates of approved design shall be furnished at each cubicle and at each instrument & device mounted on or inside the cubicle.

The material shall be lamicoid or approved equal, 3 mm thick with white letter on black background.

The name plate shall be held with self-tapping screws. Name plate size shall be minimum 20 x 75 mm for instrument/devices & 40 x 150 mm for panels.

Each panel shall be provided with plastic mounted circuit diagram on the inside of the cubicle. Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

Suitable plastic sticker labels shall be provided for easy identification of all equipment located inside the panel/module. These labels shall be positioned so as to be clearly visible and shall give the device number, as mentioned in the module wiring drawings.

20.7.28 Space Heaters and Plug Sockets

Each SG shall be furnished with thermostat controlled space heater and 5A, 3 pin plug socket.

Space heaters shall be provided in the SG to prevent harmful moisture condensation. The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase power supply.

Cubicle heater circuit shall be provided with individual switch fuse units/MCB.

20.8 TEMPERATURE RISE

The switchgear shall be designed to operate satisfactorily under the climatic conditions prevailing at site. The maximum temperature attained by any part of the entire equipment covered under this specification, at the specified ambient temperature shall not exceed the limits specified in the relevant Indian standard of the equipment.

20.9 Packing & Transport

The packing may be in accordance with the tenderer's standard practice but he shall give full particulars of packing for the approval of the purchaser. Special arrangement shall be made to facilitate handling and to protect projecting connections from damage in transit.

All parts shall be adequately marked to facilitate field erection. Boxes and crate shall be marked with the contract number and shall have a packing list enclosed, showing the parts contained therein.

During transportation of 415V LT switchgear to site, the supplier shall take all precautions/remedial measures to avoid any damage/accident etc. to transformer for timely completion of delivery at site. However, if due to any reason equipment falls down from the trailer the same will not be accepted by the purchaser and shall be replaced by new equipment without any extra cost to the purchaser.

20.10 INTERCHANGEABILITY

All similar parts of same design & rating fitted in switchgear shall be interchangeable.

20.11 ACCESSORIES

The following accessories shall be furnished along with the switchgear:

a. Breaker lifting and handling truck.

b. Device for slow opening and closing of breaker.

c. Test cabinet with coupling cables for testing the breaker in draw out position.

d. Breaker racking in/out handle (if required).

20.12 TESTS

20.12.1 Shop Tests

Each switchboard shall be assembled at the manufacturer's works with all apparatus, instruments, meters etc. connected and the various components shall be tested in accordance with the requirements of the relevant Indian Standards. These tests shall be performed in the presence of the owner's representatives.

The switchgear assembly and major components such as circuit breaker (ACBs, MCCBs), instrument transformers (CTs & VTs), relays shall be tested for all routine tests as per latest additions of relevant IS/IEC Standards.

20.12.1.1 0.415 kV Switchgear Assembly

Seismic test and type tests certificates as per relevant IS shall be submitted. If the same are not to the satisfaction of the owner, the performance which is missing shall be performed by the manufacturer at his own expense to the full satisfaction of the owner.

20.12.1.2 Non-segregated TPN bus duct

Type test report for the following tests shall be furnished along with the tender:

d) Temperature rise test
e) Insulation test
f) Short circuit test
g) Check of the protection circuits continuity
h) Check of continuity of protection
i) Seismic withstand test

20.12.1.3 Type test reports for other equipment

Type test reports from recognized test house in proof of having manufactured and tested similar equipment as per IS: 8623 (latest revision)/IEC: 439-1 shall be furnished before the supply of equipment.

Type test certificates for tests as per IS: 2516/IEC: 947-2 from a recognized test house in proof of quality of circuit breakers shall be furnished before the supply of equipment.

Type test certificates from a recognized test house as per IS: 2705, IS: 3156 and IS: 8686 in proof of- quality of current transformers, potential transformers and relays shall be before the supply of equipment.

20.12.2 Routine tests

All tests for 415V switchgear and its accessories shall be performed in the presence of owner's representatives, if so desired by the owner. The contractor shall give at least 30 days advance notice of the date when tests are to be carried out.

20.12.2.1 0.415KV switchgear assembly

All routine tests including the following tests shall be performed on each switchgear assembly as per relevant IS.

a) Physical dimensional check & verification of apparatus
b) Operation test of various apparatus
c) High voltage test
d) Insulation resistance test before and after HV test
e) Tests for verification of calibration of releases
f) Checking of protective measures & continuity of protective circuits

Various components of switchgear assembly such as ACB, MCCB, MCB, CTs, PTs, relays etc. shall be tested for routine tests in accordance with the relevant Indian Standards and test result

furnished.

The tests shall include but not necessarily limited to the following:

a. Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
b. All wiring and current carrying parts shall be given appropriate high voltage test.
c. Primary current and voltage shall be applied to all instrument transformers.
d. Routine tests shall be carried out on all the equipment such as circuit breakers, instrument transformers, Relays, meters etc.

20.12.2.2 Non segregated TPN bus duct

All routine tests as per relevant IS/IEC including following test shall be performed by manufacturer.

Power frequency voltage with stand test

The bus section shall withstand the power frequency voltage of 2.5KV (rms) for one minute.

20.12.3 Site tests

When complete switchgear has been installed and is ready for operation at site, it will be tested to determine whether or not the requirements of these specifications have been fulfilled. A list of proposed tests in addition to the following tests to be carried out at site shall be indicated in the tender. The complete bus structure will also be subjected to dielectric test in accordance with the relevant standards

a) Insulation test
b) Sequence test
c) Relay test
d) Operation test

All switchboards shall be tested for automatic switch-over & interlocking as specified.

20.12.4 Test Certificates

Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner.

The equipment shall be dispatched from works only after receipt of

Owner's written approval of the reports.

Type test certificates on above equipment shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

20.12.5 The Tenderer shall furnish the schedule of inspection and tests in the format of annexure-9.

20.13 DRAWINGS, DATA & MANUALS

Drawings, Data & Manuals shall be submitted in triplicate with the bid.

20.13.1 To be submitted with the Bid

a. General arrangement drawing showing constructional features, space required in front for withdrawals, power & control cable entry points, etc.
b. Bill of Materials.
c. Typical foundation' plan.
d. Typical breaker control schematic.
e. Matching flange & terminals for bus termination.
f. Type test reports on circuit breaker.
g. Technical leaflets on

i) Circuit breaker

ii) Instrument transformers

iii) Relays, meters, switches etc.

20.13.2 To be submitted for Approval & Distribution

Within 60 days after the issue of L.O.I. the contractor shall furnish, for approval, all the necessary drawings which describe the equipment in detail.

Four (4) copies of the following drawings, for each item shall be furnished for approval as part of the contract.

a. Outline dimensional drawing of the 415V switchgear showing general arrangement, space requirement and bus duct/cable entry points, location of terminal connections, insulators, accessories, overall assembly dimensions & weights, method of supporting the equipment from the walls, ceilings and floors wherever applicable.

b. Cross-section with parts list.

c. Foundation/fixing details.

d. Single line diagrams.

e. Control schematics.

f. Wiring diagrams.

g. Assembly and sub-assembly drawings of the important auxiliary equipment.

h. Sectional views showing the general, constructional features, operating mechanism etc.

i. Drawings/data regarding maximum loading under short circuit conditions imposed by the bus-structure on the supporting concrete.

j. Layout & cross sectional view of bus/bus-ducts, alongwith details of insulators, supporting structure for enclosures.

k. Any other drawings or information needed by Owner for co-ordination with other equipment not covered in this specification.

Detailed technical particulars such as accuracy class, VA burden, knee point voltage, magnetizing current etc for CTs and VA burden, accuracy class purpose etc for VTs installed in various feeders, bus-bars of SGs may also be indicated in the table form in the drawing.

Seven (7) copies of drawings, including one reproducible copy shall be furnished after approval. At least one month prior to dispatch of equipment seven bound copies of manual covering instructions for installation, operation & maintenance of the equipment shall be furnished to the Owner. These manuals shall include marked erection drawings, assembly drawings, results of factory test, list of spares and description of all items/components etc..

The manual shall clearly indicate the installation method, check-up and tests to be carried out before commissioning of the equipment.

The Bidder may note that the drawings, data and manuals listed herein are minimum requirements only. The Bidder shall ensure that the other necessary write-ups, curves and information required to fully describe the equipment are submitted with his bid.

20.13.3 The Tenderer shall furnish the Schedule of drawings, catalogues, manuals and other relevant information in the format of Annexure-6.

20.14 Orders for Additional Equipment

The Owner reserves the right for placing the order for similar additional

equipment, if required at a later date, but during the currency of the order. The price variation formula applicable for such equipment shall also be mentioned in the tender.

20.15 Quality Assurance Programme

The supplier has to supply the equipment for 0.415KV LT switchgear of best quality. The supplier has to maintain quality control and assurance during the manufacturing of equipment as per the approved owner's quality assurance plans. For details please refer quality assurance plan document.

20.16 DELIVERY SCHEDULE

The Tenderer shall state the shortest delivery period ha can guarantee, counting from letter of award as per format at annexure-10.

20.17 GUARANTEED AND OTHER TECHNICAL PARTICULARS

The guaranteed & other technical particulars as per Annexure-1 shall be furnished along with the tender. Any tender lacking complete information in this respect is likely to be rejected as in the absence of requisite information/data; it may not be possible for owner to evaluate the suitability & adequacy of the equipment.

20.18 SCHEDULE OF REQUIREMENTS

1. 415 V Metal Enclosed AC Unit Auxiliary Switchgears/ Boards (UAB-1 to 4) as per details given in Clause 20.18.1 - 4 sets
2. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-1) as per details given in Clause 20.18.2 - 1 set
3. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-2) as per details given in Clause 20.18.3 -1 set
4. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-3) as per details given in Clause 20.18.4 -1 set
5. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-4) as per details given in Clause 20.18.5 - 1 set
6. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-5) as per details given in Clause 20.18.6 -1 set
7. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-6) as per details given in Clause 20.18.7 -1 set
8. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-7) as per details given in Clause 20.18.8 -1 set
9. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ Board (SAB-8) as per details given in Clause 20.18.9 -1 set

10. 415 V Metal Enclosed AC Station Auxiliary Switchgear/- 1 set
Board (SAB-9) as per details given in Clause 20.18.10

11. 415 V Metal Enclosed AC Station Auxiliary Switchgear/ -1 set
Board (SAB-10) as per details given in Clause 20.18.11

12. Remote Control & Annunciation Panel as per - 1 set
details given in clause 20.7.23
13. Programmable Logic Control (PLC) System (common - 2 sets
for 11 kV & 0.415 kV switchgears) complete in all
respect such as analog to digital converters, transducers,
control and signal cables, hardware and software etc.
14. Automatic change over units
15. Terminal Blocks
16. Base channel frame with hardware, anchor bolts and lifting angles
17. Special tools and accessories
18. Spare Parts
19. All relevant drawings, data and instruction manuals
20. Bus bar of suitable cross-section with all necessary accessories for connection of dry type transformer to 0.415 kV switchgear bus bars

21. Any other accessories necessary for successful operation of equipment.

These quantities are indicative only. These will be finalized during the detail engineering stage.

20.18.1 Metal Enclosed Unit Auxiliary Switchgear/Board (UAB 1 to 4)

Each 415V A.C. metal enclosed Unit Auxiliary switchgear/board complete with ACBs, MCCBs, MCBs, bus bars, bus-bar supports, control wiring, terminal blocks, fuses, labels, indications (remote/local), interlocks, push buttons, meters, switches etc. comprising of the following: -

- 1 Set of 2000A, 50kA, LT bus bar of adequate size comprising of three phase and a neutral bus bar (size of neutral bus-bar shall be 50% of phase bus bar).

- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.

- 2 Sets of no volt relays with auxiliary contacts for protection and interlocking of incoming ACBs

- 1 Set of single phase, 3 core current transformers for restricted earth fault protection of unit auxiliary transformers, over current / earth fault protection and for metering purposes.

- 7 Sets (21 Nos.) of single phase, 2 core current transformers for over current/earth fault protection and for metering purposes.

- 1 Set of neutral earth fault protection relays (51 N) for UAT.

- 1 Set of REF relay (64 R) for UAT.

- 8 Sets of O/C and earth fault protection relays (50/64)

- 1 Set of Potential monitoring device (27/60) with auxiliary relays for directly mounting on LT bus for metering and protection.

- 8 sets of Voltmeter, 0-600V, 96x96mm size, accuracy class 1.0 with link fuse & voltage selector switch of four position “VRY-VYB-VBR-OFF” suitable for directly mounting on LT Bus.

- 8 sets of Ammeter, 0-2000A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position “IR-IY-IB-OFF” for incoming line from UAT.

- 1 No. integrating, 3-phase, 4-wire, digital energy meter.

- 1 set of 3-phase socket with earthing terminal

- 1 Lot- All other items as per requirement (refer enclosed drg. in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Manual/ON/OFF selector switch, stay put type.

- Green lamp indication for breaker “Open”.

- Red lamp indication for breaker “Close”

- Amber lamp indication for “ All healthy conditions of control supply”

- White lamp indication for "Auto Trip"
- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.
- Violet lamp indication for breaker "Spring Charged"
- Set of HRC fuses of suitable ratings for breaker close ckt., open ckt. Spring charging motor, indication circuit and protection circuit individually.
- Set of MCBs of suitable rating for 240 V AC supply.
- Set of nameplates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per tender Drg. no. Volume-IV "TENDER DRAWINGS". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.2 Details of Metal Enclosed Switchgear /Board (SAB-1)- One end of power House

415 volts A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bars, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indications (remote/local), push buttons, meters, switches etc. comprising of the following:

- 1 Set of 3200A, 50kA, LT bus bar.
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 1 Set (3 Nos.) of single phase, 2 core current transformers for over current / earth fault protection and for metering purposes.
- 1 set of Ammeter of suitable range, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position "IR-IY-IB-

OFF" for all incoming and all outgoing feeders which are connected to ACBs.

- 1 Set of O/C and earth fault protection relays (50/64)

- 1 Set of 3-phase socket with earthing terminal.

- 1 Lot- All other items as per requirement (Refer enclosed drg. in Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Manual/ON/OFF selector switch, stay put type.

- Green lamp indication for breaker "Open".

- Red lamp indication for breaker "Close"

- Amber lamp indication for "All healthy conditions of control supply"

- White lamp indication for "Auto Trip"

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE/TEST position indicators

- Violet lamp indication for breaker "Spring Charged"

- Set of HRC fuses of suitable ratings for breaker close & open circuits, spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240 V AC supply.

- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Drg. in

Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.3 Metal Enclosed Switchgear/Board (SAB-2)- One end of power House

415 Volts A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bar, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following :

- 1 Set of 415V, 4000A, 50kA, LT bus bars.
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 9 Sets (27 Nos.) of single phase, 2 core current transformers for over current/earth fault protection and for metering purposes.
- 9 Sets of O/C and earth fault relays (50/64).
- 2 Sets of no volt relays (27) with suitable auxiliary contacts for protection & interlocking of incoming ACBs from SAT-1 & SAT-2.
- 9 Sets of Ammeters, 4000A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position “IR-IY-IB-OFF” for all incoming and outgoing feeders which are connected through ACBs.
- 1 set of 3-phase socket with earthing terminal.
- 1 Lot- All other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.
- Manually reset lock out tripping relay.
- Auto/Manual/ON/OFF selector switch, stay put type.
- Green lamp indication for breaker “Open”.

- Red lamp indication for breaker “Close”
- Amber lamp indication for “All healthy conditions of control supply”
- White lamp indication for “Auto Trip”
- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE/TEST position indicators
- Violet lamp indication for breaker “Spring Charged”
- Set of HRC fuses of suitable ratings for breaker close & open circuits, spring charging motor, indication circuit and protection circuit individually.
- Set of MCBs of suitable rating for 240 V AC supply.
- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.4 Metal Enclosed Switchgear/Board (SAB-3)-One end of power House

415 Volts A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bar, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:

- 1 Set of 3200A, 50kA, LT bus bar.
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 1 Set of current transformers of single phase, 2 core for metering & protection purposes.

- 1 Set of O/C and earth fault relays (50/64).

- 1 Set of Ammeter of suitable rating, 96x96mm size, accuracy class 1.0 with ammeter selector switch of 4-position "IR-IY-IB-OFF" for incoming and outgoing feeders which are connected to ACBs.

- 1 Set of 3-phase socket with earthing terminal.

1 Lot All other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Manual/ON/OFF selector switch, stay put type.

- Green lamp indication for breaker “Open”.

- Red lamp indication for breaker “Close”

- Amber lamp indication for “All healthy conditions of control supply”

- White lamp indication for “Auto Trip”

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE/TEST position indicators

- Violet lamp indication for breaker “Spring Charged”

- Set of HRC fuses of suitable ratings for breaker close & open circuits, spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240 V AC supply.

- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.5 Metal Enclosed Switchgear/Board (SAB-4)-other end of Power House

415V A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bar, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:

- 1 Set of 1250A, 50kA, LT bus bars.
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 6 Sets of current transformers of single phase, 2 core for metering & protection purposes.
- 6 Sets of Ammeters, 0-1250A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of 4-position "IR-IY-IB-OFF".
- 6 Sets of O/C and earth fault relays (50/64).
- 1 set of 3-phase socket with earthing terminal.
- 1 Lot- All other items as per requirement (Refer enclosed drg. No. WAP/P/VP/05) and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.
- Auto/Mannual/ON/OFF selector switch, stay put type.
- Manually reset lock out tripping relay.
- Green lamp indication for breaker “Open”.
- Red lamp indication for breaker “Close”

- Amber lamp indication for " All healthy conditions of control supply"

- White lamp indication for "Auto Trip"

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.

- Violet lamp indication for breaker "Spring Charged"

- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240V AC supply.

- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.6 Metal Enclosed Switchgear/Board (SAB-5)-Transformer cavern

415V A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bars, bus-bar supports, control circuits wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:

- 1 Set of 1250A, 50kA, LT bus bar.

- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.

- 2 Sets of potential monitoring devices (27/60) with auxiliary relays suitable for directly mounting on bus-bars for metering and protection.

- 15 Sets of single phase, 2 core current transformers for metering & protection purposes.

- 13 Ammeters, 0-1250A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of 4-position "IR-IY-IB-OFF".

- 14 Sets of O/C and earth fault relays (50/64).

- 2 Sets of no volt relays (27) with suitable auxiliary contacts for protection & interlocking.

- 2 Nos. integrated, 3-phase, 4-wire digital energy meters.

- 2 Voltmeters, 0-600V, 96x96mm size, accuracy class 1.0 with fuse links & voltage selector switch of four position “VRY-VYB-VBR-OFF” mounted directly on LT bus.

- 1 set of 3-phase socket with earthing terminal.

1 Lot all other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Mannual/OFF selector switch, stay put type.

- Green lamp indication for breaker “Open”.

- Red lamp indication for breaker “Close”

- Amber lamp indication for “ All healthy conditions of control supply”

- White lamp indication for “Auto Trip”

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.

- Violet lamp indication for breaker “Spring Charged”

- Set of HRC fuses of suitable ratings for breaker close / open ckt. spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240 V AC supply.

- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.7 Metal Enclosed Station Auxiliary Switchgear/Board (SAB-6)-TRT outfall

415V A.C. metal enclosed station auxiliary switchgear/board complete with ACBs, MCCBs, MCBs, bus bars, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:-

- 1 Set of 630A, 50 kA, LT bus bar.

- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.

- 1 Set of potential monitoring device (27/60) with auxiliary relays directly mounted on LT bus for metering and protection.

- 2 Sets of single phase, 3 core current transformers for over current and earth fault protection and for metering purposes.

- 2 Sets of neutral earth fault protection relays (51N) for SAT-7 & 8.

- 2 Sets of REF protection relays (64R) for SAT- 7 & 8

- 2 Sets of O/C & earth fault protection relays (50/64)

- 2 Sets of no volt relays (27) with suitable auxiliary contacts for protection & interlocking of incoming ACBs.

- 1 Voltmeter, 0-600V, 96x96mm size, accuracy class 1.0 with fuse link & voltage selector switch of four position "VRY-VYB-VBR-OFF" suitable for directly mounting on the LT bus.

- 2 Ammeters, 0-630A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position "IR-IY-IB-OFF".
- 1 set of 3-phase socket with earthing terminal.

- 1 Lot- All other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Mannual/OFF selector switch, stay put type.

- Green lamp indication for breaker "Open".

- Red lamp indication for breaker "Close"

- Amber lamp indication for " All healthy conditions of control supply"

- White lamp indication for "Auto Trip"

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.

- Violet lamp indication for breaker "Spring Charged"

- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240V AC supply.

- Set of name plates.

- Power pack unit (if required) of sufficient capacity to meet the d.c. power requirement

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.8 Metal Enclosed Switchgear/Board (SAB-7)-Pothead yard

415 Volts A.C. metal enclosed switchgear/board complete with ACBs, MCCBs, MCBs, bus bar, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:

- 1 Set of 3200A, 50kA, LT bus bar.

- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.

- 1 Set of potential monitoring device (27/60) with auxiliary relays for metering & protection of incomers, feeders and bus-bars.

- 11 Sets of single phase, 2 core current transformers for over current / earth fault protection and for metering purposes.

- 2 Sets of neutral earth fault protection relays (51N) for SAT-9 & 10.

- 2 Sets of REF protection relays (64R) for SAT- 9 & 10.

- 2 Sets of no volt relays (27) with suitable auxiliary contacts for protection & interlocking of incoming ACBs.

- 2 Sets of single phase, 3 core current transformers for over current / earth fault protection, Restricted Earth fault and for metering purposes.

- 11 Sets of O/C & earth fault protection relays (50/64)

- 1 Voltmeter, 0-600 volts, 96x96mm size, accuracy class 1.0 with fuse link & voltage selector switch of four position "VRY-VYB-VBR-OFF" suitable for directly mounted on LT bus.

- 11 Ammeters, 0-3200A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position "IR-IY-IB-OFF" for all incoming & outgoing ACBs.

- 1 set of 3-phase socket with earthing terminal.

- 1 Lot - All other items as per requirement and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Auto/Mannual/ON/OFF selector switch, stay put type.

- Manually reset lock out tripping relay.

- Green lamp indication for breaker "Open".

- Red lamp indication for breaker "Close"

- Amber lamp indication for " All healthy conditions of control supply"

- White lamp indication for "Auto Trip"

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.

- Violet lamp indication for breaker "Spring Charged"

- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240V AC supply.

- Set of name plates.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.9 Metal Enclosed Station Auxiliary Switchgear / Board (SAB-8)-Dam site

415 V AC metal enclosed station auxiliary switchgear / board complete with ACBs, MCCBs, MCBs, bus-bars, bus-bar supports, control wiring, terminal blocks, fuses, links, labels, interlocks indication (remote/local), push buttons, meters, switches etc comprising of the following:

- 1 Set of 630A, 50 kA LT Bus-bar
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 1 set of potential monitoring device (27/60) with auxiliary relays directly mounted on LT bus for metering and protection.
- 2 sets of single phase, 3 core current transformers for over current / earth fault, restricted earth fault protections and for metering purposes.
- 2 sets of neutral earth fault protection relays (51 N) for SATs.
- 2 Sets of REF relays (64 R) for SATs.
- 8 Sets of O/C and earthfualt protection relays (50 / 64).
- 1 Voltmeter 0-600 V, 96 x 96 mm size, accuracy class 1.0 with fuse link and voltage selector switch of 4 position “VRY – VYB – BBR – OFF suitable for directly mounting on LT bus.
- 8 sets of Ammeters, 0-630 A, 96 x 96 mm size, accuracy class 1.0 with ammeter selector switch of 4 position “IR-IY-IB-OFF”.
- 3 sets of integrating, 3-phase, 4-wire, digital energy meters.
- 1 set of 3-phase socket with earthing terminal.

- 1 Lot- all other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement") and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.
- Manually reset lock out tripping relay.
- Auto/Manual/ON/OFF selector switch, stay put type.
- Green lamp indication for breaker “Open”.
- Red lamp indication for breaker “Close”
- Amber lamp indication for “All healthy conditions of control supply”
- White lamp indication for “Auto Trip”
- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE/TEST position indicators
- Violet lamp indication for breaker “Spring Charged”
- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.
- Set of MCBs of suitable rating for 240V AC supply.
- Set of name plates.
- Power pack unit (if required) of sufficient capacity to meet the D.C. power requirement

All ACBs, interlocking and accessories for complete connection & interlocking of DG sets are also in the scope of LT switchgear supplier. Interlocking should be as per clause 20.7.21.4.1.

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases

etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders and their ratings shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication. If required transformer ratings shall be enhanced accordingly. 20% spare feeders (min one) of each type and rating shall be provided.

20.18.10 Metal Enclosed Station Auxiliary Switchgear / Board (SAB-9)-Desiltation area

415V AC metal enclosed station auxiliary switchgear / board complete with ACBs, MCCBs, MCBs, bus-bars, bus-bar supports, control wiring, terminal blocks, fuses, links, labels, interlocks indication (remote/local), push buttons, meters, switches etc comprising of the following:

- 1 Set of 630A, 50 kA LT Bus-bar
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 1 set of potential monitoring device (27/60) with auxiliary relays directly mounted on LT bus for metering and protection.
- 2 sets of single phase, 3 core current transformers for over current / earth fault, restricted earth fault protections and for metering purposes.
- 2 sets of no-volt relays (27) with suitable auxiliary contacts for protection & inter locking of the incoming ACBs from SAT-13 & 14.
- 2 sets of neutral earth fault protection relays (51 N) for SATs.
- 2 Sets of REF relays (64 R) for SATs.
- 2 Sets of O/C and earthfualt protection relays (50/64).
- 1 Voltmeter 0-600 V, 96 x 96 mm size, accuracy class 1.0 with fuse link and voltage selector switch of 4 position “VRY – VYB – BBR – OFF suitable for directly mounting on LT bus.
- 2 sets of Ammeters, 0-630 A, 96 x 96 mm size, accuracy class 1.0 with ammeter selector switch of 4 position “IR-IY-IB-OFF”.

- 3 sets of integrating, 3-phase, 4-wire, digital energy meters.

- 1 set of 3-phase socket with earthing terminal.

- 1 Lot- All other items as per requirement (Refer Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement".) and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.

- Manually reset lock out tripping relay.

- Auto/Manual/ON/OFF selector switch, stay put type.

- Green lamp indication for breaker “Open”.

- Red lamp indication for breaker “Close”

- Amber lamp indication for “All healthy conditions of control supply”

- White lamp indication for “Auto Trip”

- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE/TEST position indicators

- Violet lamp indication for breaker “Spring Charged”

- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.

- Set of MCBs of suitable rating for 240V AC supply.

- Set of nameplates.

- Power pack unit (if required) of sufficient capacity to meet the D.C. power requirement

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases

etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.18.11 Metal Enclosed Station Auxiliary Switchgear/Board (SAB-10)-Butterfly Valve Chamber

415V A.C. metal enclosed station Auxiliary switchgear/board complete with ACBs, MCCBs, MCBs, bus bars, bus-bar supports, control wiring, terminal blocks, fuses, labels, interlocks indication (remote/local), push buttons, meters, switches etc. comprising of the following:-

- 1 Set of 630A, 50kA, LT bus bar.
- 1 Set base channel frame with all necessary hardware anchor bolts, lifting angles etc. for complete installation of equipment.
- 1 Set of potential monitoring device (27/60) with auxiliary relays directly mounted on LT bus for metering and protection.
- 2 Sets of single phase, 3 core current transformers for over current and earth fault protection and for metering purposes.
- 2 Sets of neutral earth fault protection relays (51N) for SAT-15 &16.
- 2 Sets of REF protection relays (64R) for SAT- 15 & 16
- 2 Sets of O/C & earth fault protection relays (50/64)
- 2 Sets of no volt relays (27) with suitable auxiliary contacts for protection & interlocking of incoming ACBs.
- 1 Voltmeter, 0-600V, 96x96mm size, accuracy class 1.0 with fuse link & voltage selector switch of four position “VRY-VYB-VBR-OFF” suitable for directly mounting on the LT bus.
- 2 Ammeters, 0-630A, 96x96mm size, accuracy class 1.0 with ammeter selector switch of four position “IR-IY-IB-OFF”.
- 1 set of integrating, 3-phase, 4-wire, digital energy meters.
- 1 set of 3-phase socket with earthing terminal.

- 1 Lot- All other items as per requirement (Refer enclosed drg No. WAP/P/VP/04) and broadly specified as under:

- Breaker open/close control switch of spring loaded return to neutral type.
- Manually reset lock out tripping relay.
- Auto/Mannual/OFF selector switch, stay put type.
- Green lamp indication for breaker “Open”.
- Red lamp indication for breaker “Close”
- Amber lamp indication for “All healthy conditions of control supply”
- White lamp indication for “Auto Trip”
- Blue lamp indication for all alarm conditions e.g. over load and also for SERVICE / TEST position indicators.
- Violet lamp indication for breaker “Spring Charged”
- Set of HRC fuses of suitable ratings for breaker close / open ckt. Spring charging motor, indication circuit and protection circuit individually.
- Set of MCBs of suitable rating for 240V AC supply.
- Set of name plates.
- Power pack unit (if required) of sufficient capacity to meet the d.c. power requirement

These quantities are indicative only. These may be varied according to the requirements.

The incoming and outgoing feeders containing ACBs & MCCBs complete with operating mechanism and thermal & magnetic releases etc complete in all respect shall be provided generally as per Section-30: "Tender Drawings" of Part-2: Section VI: "Employer's Requirement". However the exact nos. of outgoing feeders shall be finalized as per actual requirement at the time of detailed engineering and the same shall be provided without any additional financial implication.

20.19 SCHEDULE OF SPARE PARTS

The mandatory spare parts as indicated in the Annexure-2 shall be furnished by the bidder.

The bidder is required to furnish a list of recommended spare parts, if any, in the prescribed schedule as per enclosed format of Annexure-3.

All spare parts supplied shall be interchangeable and shall be of same material & workmanship as the corresponding parts of the main equipment.

20.20 COMPLETENESS OF EQUIPMENT

All fittings and accessories of the equipments which may not have specifically mentioned in these specifications, but are usually necessary for the completeness and successful commissioning of the above equipment, shall be deemed to be covered by the specification and shall be indicated and furnished by the bidder without any extra cost to the purchaser.

20.21 TOOLS & PLANTS, TESTING DEVICES, CONSUMABLES ETC.

The bidder shall supply one complete set comprising of all tools, special tools, Instruments & testing devices required for O&M of 0.415kV metal enclosed switchgears / boards and associated equipments. The price wise list of each tool shall be indicated in the price schedule.

The equipments, tools, devices, instruments & consumables required for site assembly, erection, testing & commissioning of 0.415 kV metal enclosed switchgears / boards shall be provided by the bidder without any extra cost to THDC.

The Tenderer shall furnish the tools, special tools and testing devices etc. in the format of Annexure-7.

20.22 GUARANTEED PERFORMANCE

The performance figures quoted in technical particulars sheets shall be guaranteed with in the tolerance permitted by relevant Standard. In case of failure of the equipment to meet the guarantee, the equipment may be liable for rejection.

ANNEXURE-1

SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS

Sl. No.	Description of Items	Unit	Data

415V LT Switchgear

1. A) Panels / Boards (indicate separately for each type rating)

i) Manufacturer's name & country of manufacture

ii) Manufacturer's type & designation

iii) Applicable standard

iv) Rated operational voltage V

v) Rated insulation voltage*

a) Highest system voltage V
b) Power frequency withstand voltage kV

vi) Rated voltage of auxiliary circuits V

vii) Maximum operating voltage* V

viii) Symmetrical short circuit current rating at rated voltage* kA

ix) Peak short circuit withstand current* kA_{peak}

x) Degree of protection

xi) Service conditions i.e. indoor or outdoor

xii) Overall dimensions of panel* (LxBxH) mm

a) Single front -
b) Double front -

xiii) Shipping dimensions of largest package (LxBxH) mm

xiv) Weight of panel Kg

g) Single front
h) Double front

xv) Shipping weight of largest package — Kg

1. B) Busbars (Indicate separately for each rating)

i)	Name of manufacturer	
ii)	Conductor material	
iii)	Cross-section	mm^2
iv)	Clearance between phases	mm
v)	Phase-earth clearance	mm
vi)	Rated short time current and its duration	kA/sec
vii)	Dynamic current rating	$kA_{(peak)}$
viii)	Rated continuous current at specified ambient temperature	A
ix)	Maximum temperature rise over ambient temp.	^0C
x)	Applicable standards	
xi)	Whether bus joints silver plated	Yes/No
xii)	Material for phase barrier	
xiii)	Voltage class for support and bushing insulators	V

1. C) Bus Duct (indicate separately for each rating)

i) Name of manufacturer

ii) Type of bus-duct

iii) Bus enclosure material

iv) Size (thickness) of enclosure material — mm

v) Applicable standards

2. Air Circuit Breakers (indicate separately for each rating)

i) Name of manufacturer

ii) Manufacturer's type designation

iii) Applicable standards

iv) Number of poles — Nos.

v) Rated operational voltage — V

vi) Rated current — A

vii)	Rated Frequency	Hz
viii)	Short circuit performance category	
ix)	Rated short circuit breaking current*	kA
x)	Rated short circuit making current*	kA
xi)	Rated short time withstand current for 1 second *	kA
xii)	Rated insulation voltage*	
	c) Highest system voltage	V
	d) Power frequency withstand voltage	kV_{rms}
xiii)	Thermal overload and short circuit releases	
	a) Whether C.T. operated/thermo magnetic type	
	b) Definite time lag	
	c) Total operating time for complete clearance of fault	
xiv)	Breaker Operating times*	ms
	a) Opening time	
	b) Making time	
	c) Arc duration	
xv)	Type and material of main contacts*	
xvi)	Type and material of arcing contacts*	
xvii)	Breaker Closing Device	
	a) Whether manual or motor operated	
	b) Whether the circuit breaker is fitted with making current release	
	c) Whether the circuit breaker is fixed trip or trip free type	
	d) Whether indication for individual release provided	
xviii)	Normal voltage of closing mechanism	V
xix)	Normal voltage of tripping mechanism or shunt trip	V
xx)	Power required at designated normal voltage to:	W

a) Close the circuit breaker
b) Open the circuit breaker

xxi) Type and rating of spring charging motor W

xxii) Voltage of spring charging motor V

xiii) Emergency manual charging facility provided Yes/No

xxiv) Weight of circuit breaker complete with arc extinguishing medium mechanism Kg

xxv) Normal range of current setting A

xxvi) Overall dimensions (LxBxH) mm

xxviii) Following test certificates shall be enclosed -

a) Test certificate for P-2 category
b) Test certificate for mechanical life
c) Test certificate for temperature rise
d) Type test certificate short circuit withstanding capacity

3. Moulded Case Circuit Breakers (indicate separately for each type of rating)

i) Name of manufacturer and manufacturer's type designation

ii) Applicable standards

iii) No. of poles

iv) Rated operational voltage V

v) Normal current A

vi) Frequency Hz

vii) Short circuit performance category

viii) Rated short circuit breaking current* kA

ix) Rated short circuit making current* kA

x) Rated short time withstand current for 1 second* kA

xi) Rated insulation voltage*
- a) Highest system voltage V
- b) Power frequency withstand voltage kV

xii) Overload and short circuit release :

- a) Whether thermal over load adjustment provided and its range of adjustment
- b) Whether magnetic short circuit protection adjustment provided and its range of adjustment
- c) Definite time lag Sec
- d) Total operating time for complete clearance of fault ms

xiii) Type and material of main contacts*

xiv) Type and material of arcing contacts*

xv) Whether the circuit breaker is fitted with making current release

xvi) Whether the breaker is trip free

xvii) Weight of the circuit breaker Kg

xviii) Overall dimensions of the breaker (LxBxH) mm

xix Breaker operating time* ms

- a) Opening time
- b) Arc duration for breaking current

xx) The following test certificates shall be enclosed -

- a) Test certificate for P-2 category
- b) Test certificate for mechanical life
- c) Test certificate for temperature rise
- d) Type test certificate for short circuit withstand capacity

4. Miniature Circuit Breakers (indicate separately for each type of rating)

i) Name of manufacturer and manufacturer's type designation

ii) Applicable standards

iii) No. of poles

iv) Rated operational voltage V

v) Normal current A

vi) Frequency Hz

vii) Short circuit performance category

viii) Rated short circuit breaking current* kA

ix) Rated short circuit making current* kA

x) Rated short time withstand current for 1 second* kA

xi) Rated insulation voltage*
- e) Highest system voltage V
- f) Power frequency withstand voltage kV

xii) Overload and short circuit release

- g) Whether thermal over load protection provided
- h) Whether magnetic short circuit protection provided
- i) Total operating time for complete clearance of fault

xiii) Type and material of main contacts*

xiv) Type and material of arcing contacts*

xv) Whether the circuit breaker is fitted with making current release

xvi) Whether the breaker is trip free

xvii) Weight of the circuit breaker Kg

xviii) Overall dimensions of the breaker (LxBxH) mm

xix Operating Time* ms

- a) Opening time
- b) Arc duration for the breaking current

xx) The following test certificates shall be enclosed -

a) Test certificate for P-2 category

b) Test certificate for mechanical life

c) Test certificate for temperature rise

d) Type test certificate for short circuit withstanding capacity

5. Current Transformers (indicate separately for each rating)
(Give details separately for each type of CT)

i)	Name of manufacturer and manufacturer's type designation	
ii)	Applicable standards	
iii)	Rated voltage	V
iv)	Frequency	Hz
v)	Rated primary and secondary current	Amp
vi)	Rated output	VA
vii)	Accuracy class	
viii)	Highest system voltage*	V
ix)	Rated insulation level* (Power frequency withstand voltage)	kV
x)	Rated short time thermal current*	kA
xi)	Rated dynamic current*	kA
xii)	Resistance of secondary winding*	Ω
xiii)	Accuracy limit factor*	
xiv)	Exciting current*	mA
xv)	Instrument security factor	
xvi)	Class of insulation	
xvii)	Following type test certificates shall be enclosed:	

a) Short time withstand current tests
b) Temperature rise test
c) Power frequency withstand tests on primary and secondary windings

6. Potential Transformers (indicate separately for each class/rating)
(Give details separately for each type of PT)

i)	Name of manufacturer and manufacturer's type designation	
ii)	Applicable standards	
iii)	Rated primary and secondary voltage	V
iv)	Rated frequency	Hz
v)	Rated output	VA
vi)	Accuracy class	
vii)	Highest system voltage*	V
viii)	No. of phases and method of connection	
ix)	Type of earthing (earthed or unearthed)	
x)	Class of insulation	
xi)	Following type test certificates shall be enclosed -	

a) Power frequency withstand tests on primary and secondary windings
b) Temperature rise test

7. Over Current And Earth Fault Relays (50/64)

i)	Name of manufacturer and manufacturer's type designation	
ii)	No. of over current relays per circuit breaker	
iii)	No. of earth fault relays per circuit breaker	
iv)	Current rating (1A or 5A)	A
v)	Setting ranges	A
vi)	Pick up current* (% of set value)	A
vii)	Operating current* (% of set value)	A
viii)	Dropout current* (% of set value)	A
ix)	Time settings	ms
x)	Burden on C.T. at various settings	VA
xi)	C.T. requirements	
xii)	Thermal rating	A
xiii)	Accuracy	
xiv)	Coil ratings of auxiliary units and its burden A/VA	
xv)	Contact ratings	V/A
xvi)	Insulation withstand voltage*	V
xvii)	Overall Dimensions (LxBxH)	mm

8. Voltage Relays

i)	Name of manufacturer and manufacturer's type designation	
ii)	No. of voltage relays per circuit breaker	
iii)	Voltage rating	V
iv)	Voltage setting ranges	V
v)	Pick up voltage (% of set value)*	V
vi)	Operating voltage (% of set value)*	V
vii)	Dropout voltage (% of set value)*	V
viii)	Time setting ranges	ms
ix)	Burden per phase on the potential transformer	VA
x)	P.T. requirements	
xi)	Thermal rating	A
xii)	Accuracy	
xiii)	Coil ratings of auxiliary units' i.e .voltage, burden V/VA	
xiv)	Contact ratings	V/A
xv)	Insulation withstand voltage*	kV
xvi)	Overall Dimensions (LxBxH)	mm

9. Tripping Relay

i)	Name of manufacturer and manufacturer's type designation	
ii)	Coil ratings	V/A
iii)	Voltage band for satisfactory operation	V
iv)	Operating time	ms
v)	Burden	VA
vi)	Thermal rating	A
vii)	Contact ratings	V/A
viii)	Insulation withstand voltage*	kV
ix)	Overall Dimensions (LxBxH)	mm

10. Fuses

i)	Make	
ii)	Type	
iii)	Applicable standards	
iv)	Rated voltage	V
v)	Rupturing capacity*	kA
vi)	Peak cut off current*	kA
vii)	Whether mounted on an insulated carrier	

11. Auxiliary Contactors

i)	Make	
ii)	Type	
iii)	Coil voltage	V
iv)	Coil burden	VA
v)	Operating time	ms
vi)	Nos. of contacts (NO+NC)	
vii)	Current rating of contactors*	A

12. Control / Selector Switches

i)	Make	
ii)	Type designation	
iii)	Voltage grade	V
iv)	Current rating*	A
	a) Continuous rated current	
	b) Making current	
	c) Breaking current	
v)	Spring return or stay put type	
vi)	Type of handle	
vii)	No. of positions	
viii)	No. of poles/way	
ix)	Contact materials and plating	